Exotic Pest Detection Manual

US Department of Agriculture
Animal and Plant Health
Inspection Service
Plant Protection and Quarantine

United States
Department of
Agriculture

Animal and
Plant Health
Inspection
Service

Plant Protection
and Quarantine

Pest Recognition Sheets

Exotic Pheromone Trapping Project

Note:
Pinned specimens of suspected exotics from this exotic trapping project may be sent to:

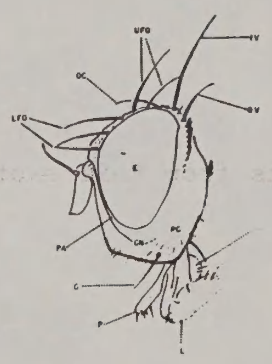
Systematic Entomology Laboratory
Room 01, Building 003
BARC-West
Beltsville, MD 20705

Please submit specimens with a PPQ Form 391 and designate as urgent material from APHIS-PPQ EXOTIC TRAPPING PROJECT.

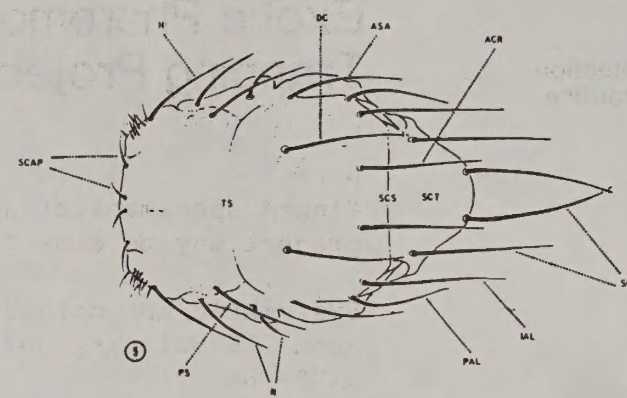
Cooperative National Plant Pest Survey
and Detection Program

Rhagoletis cerasi (Linnaeus) (DIPTERA: TEPHRITIDAE)

Distribution: Europe



head, lateral view



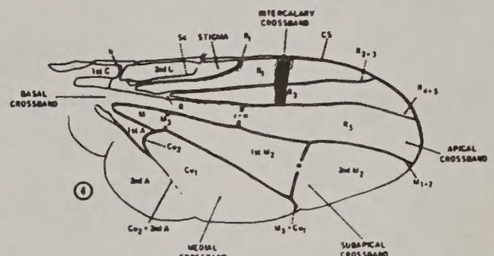
thorax, dorsal view

The genus Rhagoletis has the following characters:

1. An ivory to yellowish-white stripe reaching from the humeral callus (shoulder) to the base of the wings.

2. A wing pattern of transverse yellowish to brownish black bands; with r-m crossvein at the center of the first M2 cell.

3. The frons is slightly wider at the vertex than at the level of the antennae, but is narrower than the maximum width of the eye; gena (GN) about 0.12 to 0.23 height of head.

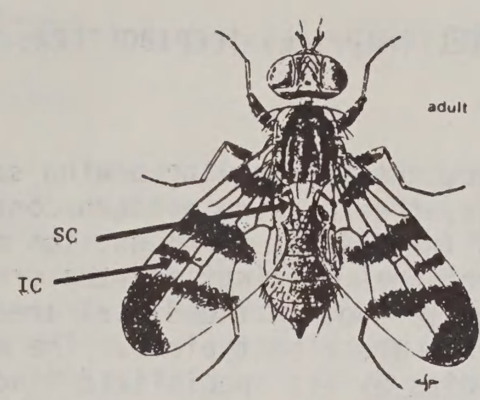


wing venation

4. Ocellar bristles (OC) on head approximately same length as upper fronto-orbital bristles (UFO); three pairs of convergent lower fronto-orbitals (LFO) between eyes, two pairs of reclinate divergent upper fronto-orbitals (UFO),

5. Dorsocentral bristles (DC) of thorax located slightly before, on, or slightly behind a line drawn between anterior supraalar bristles (ASA). They are always closer to supraalars than to either transverse sulcus or to acrostichal bristles (ACR).

6. Femora of second and third pair of legs without well-developed spines along bottom of margin.



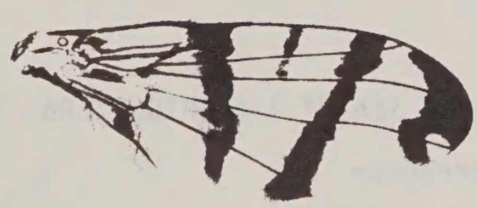
adult, Rhagoletis cerasi (L.)

Rhagoletis cerasi (L.) can be separated from other species of Rhagoletis in North America by the following characters:

1. The scutellum (SC) is completely cream to yellowish-white without a distinct spot; at base only, it may be dark on the sides.

2. The wing pattern has a small intercalary crossband (IC).

3. Body mostly black with yellow to white markings.



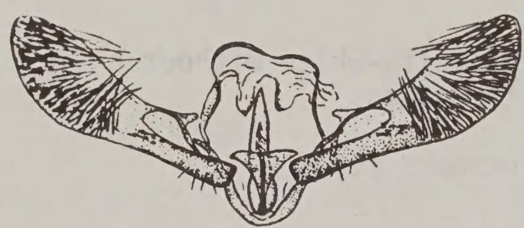
R. alternata (Fallen) (Europe)

R. alternata (Fallen) in Europe resembles R. cerasi but alternata has a slightly different pattern of crossbands.

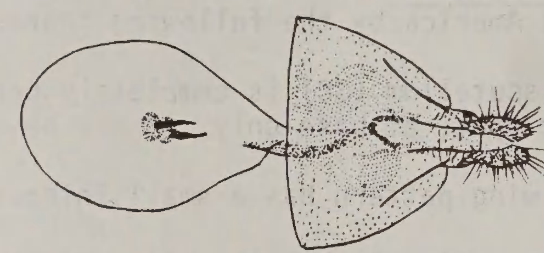
Cryptophlebia leucotreta (Meyrick) (LEPIDOPTERA: TORTRICIDAE)

Distribution: southern Africa

The adults are sexually dimorphic, the male having a wing span of 15-16mm and the famale 19-20mm; in both sexes, the forewing pattern consists of a mixture of plumbeious, brown, black, and ferruginous markings, the most conspicuous being the blackish triangular pretornal marking, and the crescent-shaped marking above it, and a minute white spot in the discal area. Dark markings in the apical portion of the forewings are also typical. The male is at once distinguished from all other species by its specialized hindwing, which is slightly reduced and has a circular pocket of fine hair-like black scales overlaid with broad weakly shining whitish scales in the anal angle, and its heavily tufted hind tibia.



male genitalia



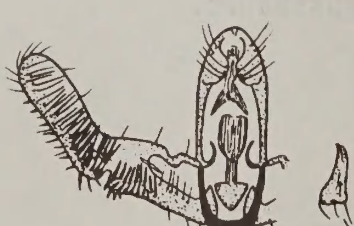
female genitalia

Other genera with expanded tufts on hind legs are Melissopus (one U.S. species), Phaecasiophora (three U.S. species), Cydia injectiva (Heinrich), and some species of Ecdytolopha.

Lobesia botrana (Den. & Schiff.) (LEPIDOPTERA: TORTRICIDAE)

Distribution: Europe, Mediterranean

Wing expanse is 10-17 mm. Male has hindwing white, weakly scaled, female has hindwing dark greyish fuscous. Forewing pattern: the plumbeous suffusion of the ground color of the forewing, forming a subquadrate patch medio-dorsally and bordering the outer edge of the median fascia costally and enclosing the tornal marking, is characteristic of the species.



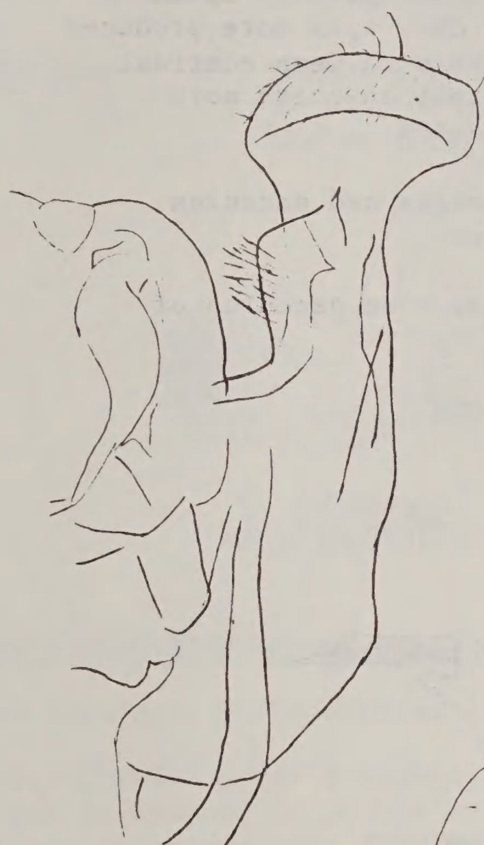
male genitalia

Resembles Endopiza viteana Clemens (Paralobesia viteana (Clemens)), the grape berry moth, in the United States very closely; but male genitalia are distinct and venation is distinct, i.e., R2 and R3 of forewing rather close together at base in L. botrana, while in E. viteana R2 and R3 are well separated.

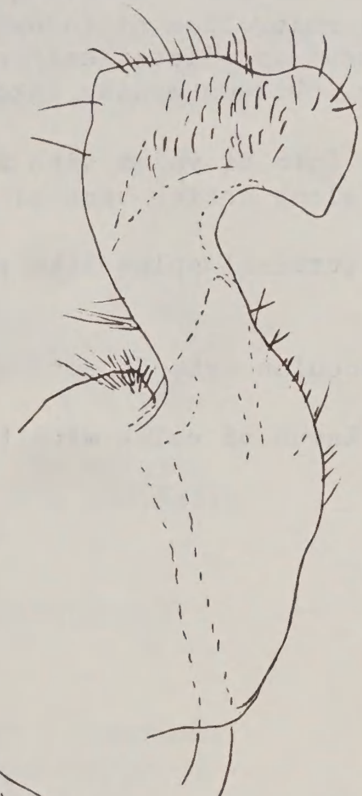
Mamestra brassicae Linnaeus (LEPIDOPTERA: NOCTUIDAE)

DISTRIBUTION: Europe, Asia

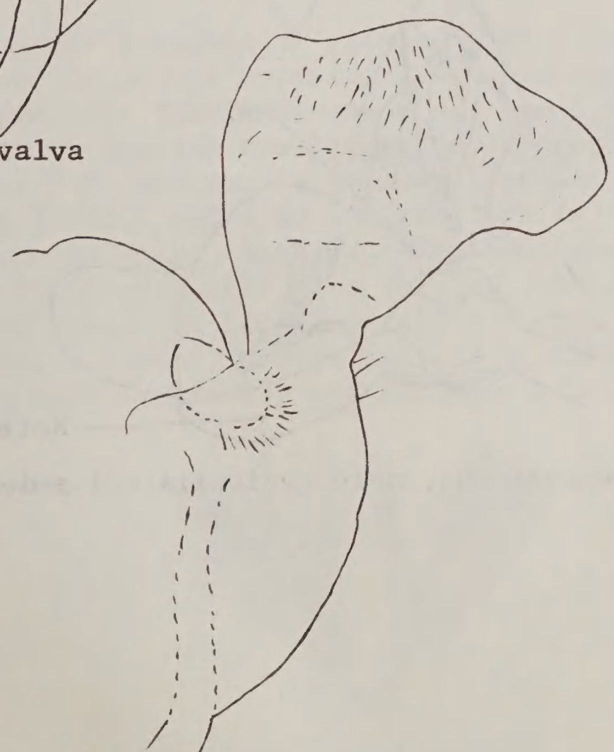
The subfamily Hadeninae is recognized by the hair on the surface of the eyes. *M. brassicae* has the subterminal line not defined by whitish on the inner side, this separates *brassicae* from *M. configurata* Walker,a U.S. species which has subterminal line prominently defined by whitish on the inner side; wing expanse of *M. brassicae* is approximately 44 mm. Differences in male genitalia allow separation of *M. brassicae* from *M. configurata* and *M. curialis*(*Sm.*). (See figures.)



M. brassicae, valva



M. configurata, valva



M. curialis, valva

Epiphyas postvittana (Walker) (LEPIDOPTERA: TORTRICIDAE)

DISTRIBUTION: Australia, New Zealand, Hawaii, England

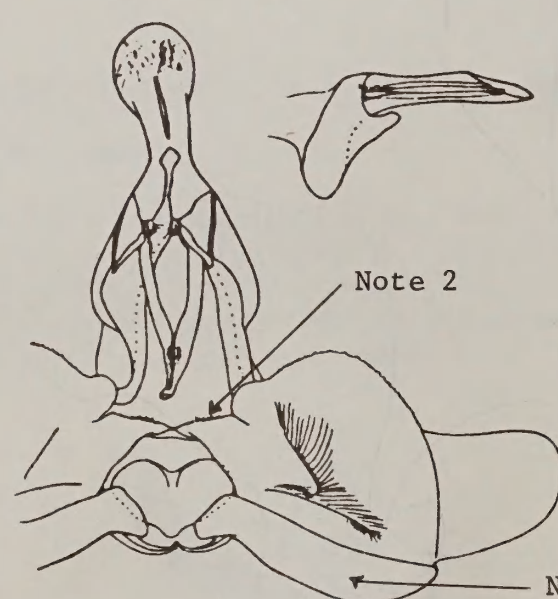
Sexual dimorphism pronounced. MALE: forewing expanse 16-21 mm; basal half of forewing light buff or pale yellow, sharply contrasting with the dark brown and brownish-red coloration of distal half, pre-apical spot on costa obscure; hindwing grey. The wing pattern is extremely variable. There are lightly marked forms which resemble the female in which there is only an oblique median fascia and a pre-apical spot noticeable, and there are forms in which the distal half is extremely dark, varying from reddish-brown to blackish often with purplish mottling, the contrasting pale basal half may be sparsely speckled with black. FEMALE: forewing expanse 17-25 mm., apex more produced than male; coloration of forewing more uniform with less contrast between basal and distal halves, pre-apical spot on costa more noticeable, oblique median fascia usually reduced.

Epiphyas: form of valva with its basal processes and sacculus extending along entire ventral length of valva

Archips: terminal spine-like projection present on sacculus of valva

NOTE 1: sacculus extends entire length of valva

NOTE 2: clavus of valva with teeth



E. postvittana, male genitalia and aedeagus

Cydia funebrana (Treitschke) (LEPIDOPTERA: TORTRICIDAE)

Distribution: Europe, Mediterranean

NOTE: Some European taxonomists include Grapholita as subgenus of Cydia. Grapholita including funebrana (Treitschke))has a pair of long heavy hair tufts at apex of abdomen which distinguishes this group.

Grapholita molesta: smaller in size, male has patch of pale scales along middle of termen (outer edge) of hindwing; both sexes have better defined fasciate markings than funebrana and a white discocellular spot on forewing at two-third length of wing near middle. Wing expanse is 11-13 mm.

Cydia funebrana: slightly larger in size, wing expanse approximately 15 mm., no white discocellular spot or patch of pale scales along middle of termen of hindwing.

C. Funebrana
male genitalia

G. molesta
male genitalia

Autographa gamma Linnaeus (LEPIDOPTERA: NOCTUIDAE)

DISTRIBUTION: Europe, Mediterranean

The subfamily Plusiinae has a number of species with a prominent silver stigma in the center of the forewing. Male genitalia of Autographa are quite similar. Wing expanse of A. gamma is 36-40 mm. Similar-looking species are Syngrapha celsa (Hy. Edw.) which occurs in Western U.S. and can be separated by its spined tibiae, A. pseudogamma (Grote) which is a boreal species occurring in Alaska and Canada, south to Maine, Michigan, South Dakota, Montana, Wyoming, Arizona, and California, (In this species the length of the aedeagus is about seven times the length of the cornutus.) and A. californica (Speyer) which occurs in Western U.S. to Kansas and Nebraska and resembles A. gamma both externally and in genitalia.

A. gamma, male genitalia

Adoxophyes orana (Fischer von Rosslerstamm) (LEPIDOPTERA: TORTRICIDAE)

Distribution: Europe

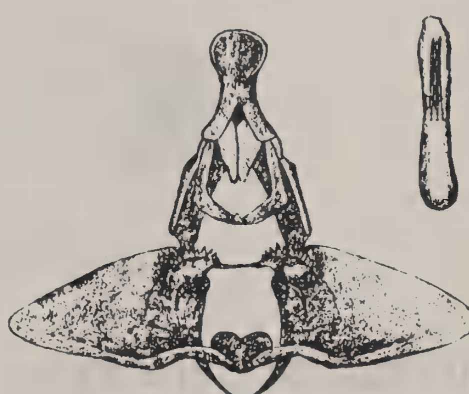
Wing expanse is 15-22 mm; sexual dimorphism pronounced in forewing

head, lateral view

wing venation

male genitalia

Resembles a large number of other moths in this family. Very closely resembles two U.S. species, Adoxophyes furcatana (Walker) and A. negundana (McDunnough) but there are slight differences in male genitalia.

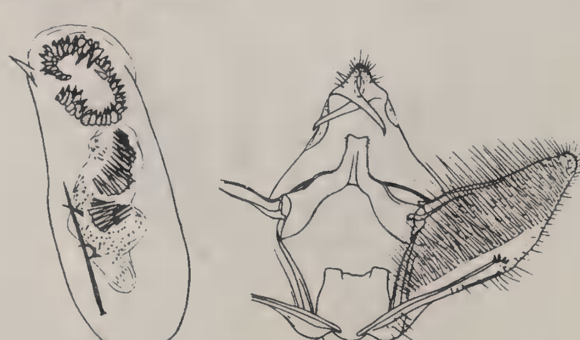


Adoxophyes furcatana (Walker) male genitalia, U.S.A.

Eupoecilia ambiguella Hubner (LEPIDOPTERA: COCHYLIDAE)

DISTRIBUTION: Europe, Asia, Brazil

Forewing expanse 12-15 mm; ground color of forewings pale ochreous-white with dots and mottling of black and yellow-ochreous. Wide median fascia oblique on distal side, coloration blackish with ferrugineous spots in dorsal half.



E. ambiguella, aedeagus, male genitalia

Chilo partellus (Swinhoe) (LEPIDOPTERA: PYRALIDAE)

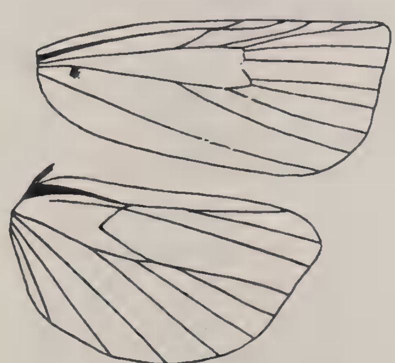
DISTRIBUTION: East Africa, India, Afghanistan

Chilo suppressalis (Walker) (LEPIDOPTERA: PYRALIDAE)

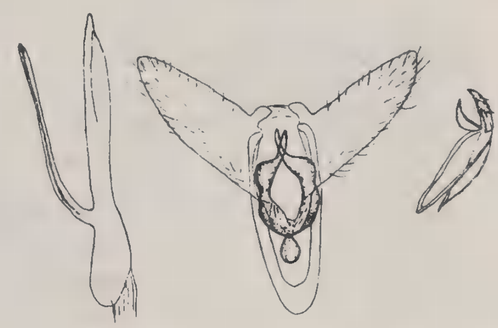
DISTRIBUTION: Spain, Asia, Hawaii

In both species ocelli above compound eye are well developed (in *Diatraea* no ocelli are present); forewing venation has R2 and R5 free, R3-R4 stalked; hindwing venation has M1 from upper angle of cell, M2 present. Both species can be separated by the shape of the juxta-plate (which occurs between the bases of the valvae in the center of the genitalia). Note the long arms on the juxta-plate. *C. partellus* has length of a forewing (not forewing expanse) varying from 7-17 mm; *C. suppressalis* has forewing length varying from 11-14 mm.

MALE GENITALIA: aedeagus; ventral view of juxta-plate and valvae; lateral view of uncus and gnathos



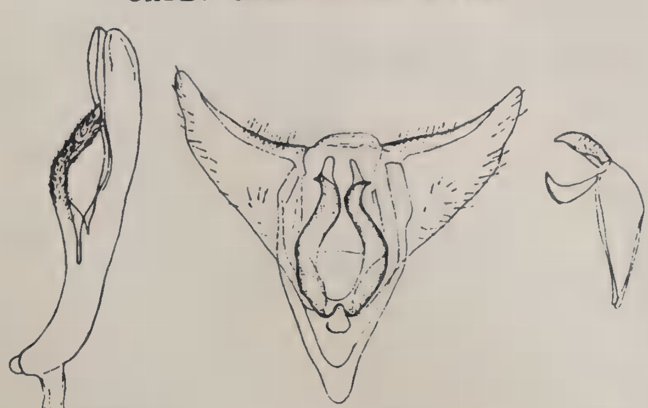
Chilo partellus (Swinhoe)



Chilo suppressalis (Walker)

Chilo demotellus Walker

Chilo erianthalis Capps



Chilo plejadellus Zincken

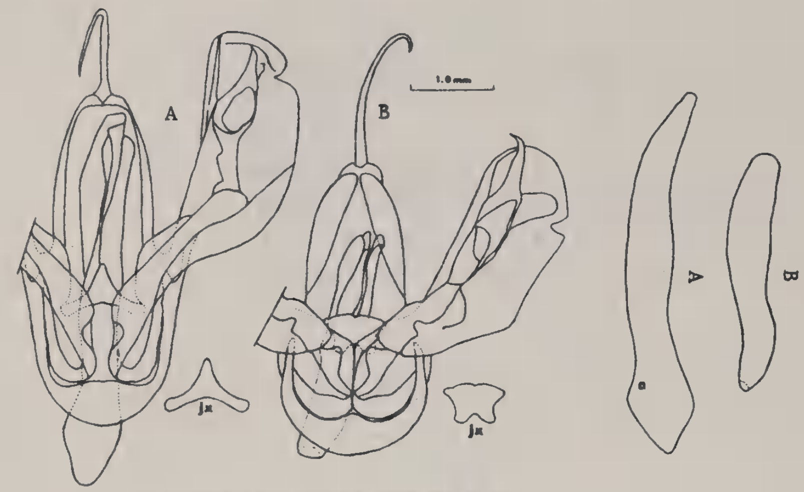
Chilo chiriquitensis (Zeller)

Spodoptera litura (Fabricius) (LEPIDOPTERA: NOCTUIDAE)

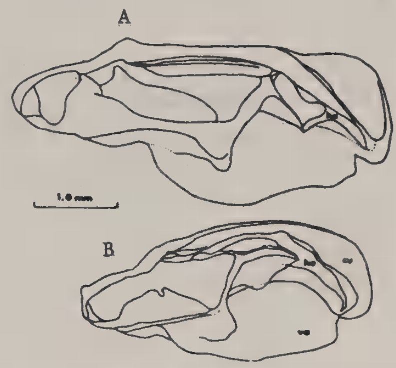
Distribution: Asia, Australia

Spodoptera littoralis (Boisduval) (LEPIDOPTERA: NOCTUIDAE)

Distribution: Africa, Mediterranean



Male genitalia of *S. litura* (A) and *S. littoralis* (B). jx, juxta.



Right valvae of the male genitalia of *S. litura* (A) and *S. littoralis* (B). cu, cucullus; ha, harpe; va, valvula.

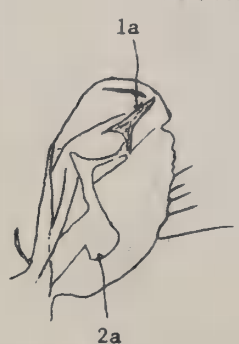
Spodoptera litura and S. littoralis can be confused with three U.S. species: S. ornithogalli (Guenee), S. latifascia (Walker), and S. praefica (Grote). Separation of the exotic species from the U.S. species can be done on the basis of the following characters of males:

litura, littoralis: well-defined oblique band from costa of forewing through the orbicular ending at about the midpoint of the postmedial line; no discal dot in middle of hindwing; dorsal surface of thorax more variegated light brown and dark brown; hook in genitalia moderate and straight (see 1a); valva has shape as shown in 2a.

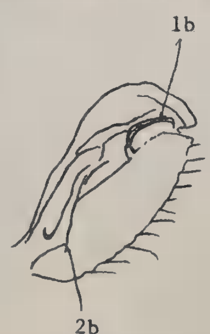
ornithogalli: well-defined oblique band from costa of forewing through the orbicular ending at about the midpoint of the postmedial line; no discal dot in middle of hindwing; dorsal surface of thorax a more uniform brown; the hook in genitalia thinner and definitely curved (see 1b); valva has shape as shown in 2b.

latifascia: oblique band absent and replaced by a light cream to tan-colored orbicular; no discal dot in middle of hindwing; hook in genitalia massive and curved (see 1c); valva has shape as shown in 2c.

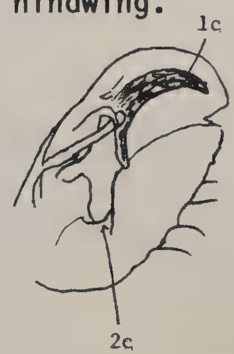
praefica: distinct discal dot in middle of hindwing.



S. litura
right valva



S. ornithogalli
right valva



S. latifascia
right valva

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EXOTIC PEST DETECTION SURVEY GUIDELINES

This manual contains survey guidelines for exotic insect species. Included are 1) general trapping guidelines, 2) trapping density guidelines, 3) methodology for removing insects from traps, 4) specific information on each target species, 5) host crop distribution maps, 6) identification aides, and 7) a compilation of non-target species commonly captured in traps.

Listed below are approved common and scientific names and EPA codes of insects covered in this manual and codes used in reference to pheromone dispensers.

Scientific Name	Family & Order	Common Name	Otis MDC Pheromone Code	EPA Code
Adoxophyes orana	Lepidoptera:Tortricidae	Summer fruit tortrix moth	ADOX	ITBUETA
Autographa gamma	Lepidoptera:Noctuidae	Silver Y moth	AG	ITBCFCA
Chilo partellus	Lepidoptera:Pyralidae	Maize borer	CP	ITBMEVA
Chilo suppressalis	Lepidoptera:Pyralidae	Asiatic rice borer	CS	ITBMAOA
Cryptophlebia leucotreta	Lepidoptera:Tortricidae	False codling moth	FCM	ITBUEUA
Cydia funebrana	Lepidoptera:Tortricidae	Plum fruit moth	PFM	ITBUESA
Epiphyas postvittana	Lepidoptera:Tortricidae	Light brown apple moth	LBAM	ITBUBPA
Eupoecilia ambiguella	Lepidoptera:Tortricidae	European grape berry moth	EA	ITBIAEA
Leucoptera malifoliella	Lepidoptera:Lyonetiidae	Pear leaf blister moth	PLBM	ITAYAKA
Lobesia botrana	Lepidoptera:Tortricidae	Grape vine moth	LB	ITBUDUA
Mamestra brassicae	Lepidoptera:Noctuidae	Cabbage moth	MB	ITBCDMA
Rhagoletis cerasi	Diptera:Tephritidae	European cherry fruit fly	RC	IOBMCDA
Spodoptera littoralis	Lepidoptera:Noctuidae	Egyptian cottonworm	ECL	ITBCFPA
Spodoptera litura	Lepidoptera:Noctuidae	Rice cutworm	CL	ITBCFMA
Trogoderma granarium	Coleoptera:Dermestidae	Khapra beetle	KB	INATANA
Yponomeuta malinellus	Lepidoptera:Yponomeutidae	Apple ermine moth	AEM	ITBWAPA

USDA, APHIS, Plant Protection and Quarantine will coordinate purchase of traps and pheromone dispensers for these species through PPQ regional offices. If there are specific questions concerning traps, trap placement, trap servicing or pheromone dispensers, please contact Otis Methods Development Center (508)-563-9303.

The information in this manual was compiled by the Otis Methods Development Center with inputs from the Survey and Emergency Response Staff and the Insect Identification and Beneficial Insect Introduction Institute, ARS.

GENERAL TRAPPING GUIDELINES

Careful preparation and handling of traps and baits is an important part of conducting a productive detection survey. Traps should be assembled according to instructions provided, giving particular attention to critical dimensions (e.g. entry port openings). Damaged traps that have tack-trap on the outside surfaces or do not have enough tack-trap on the inside (catching surfaces) should be discarded or returned. Baits (pheromone dispensers) should be handled carefully to prevent contamination of the outside trap surfaces or cross contamination with other baits. Careful handling of baits with forceps or disposable rubber gloves should prevent contamination of the trapper and the traps. Forceps should be cleaned and gloves should be changed when switching bait types. Preparing all trap components first, and subsequently baiting these traps with lures, should also minimize contamination of the outer trap surfaces.

Baits should be placed in traps so that when traps are serviced the bait can easily be removed. Bait holders are provided with all baits. Under no circumstances should baits be placed in the adhesive (i.e. tack-trap). Placement of polycap (and rubber septum) type bait dispensers is facilitated by using a plastic bait holder which is stapled to the inside of the trap. Do not open polycap dispensers. Other pheromone dispenser types (hollow fibers and laminates) can simply be stapled centrally on the upper side of the trap top.

Unused traps should be stored in a cool, dry area that is free of pheromone dispensers. Baits not in foil pouches should be stored in tightly sealed glass containers. All baits should be stored in a freezer or refrigerator. Again, care should be exercised so that different bait types are not mixed in the same container (which would result in cross contamination). Bait dispensers and containers of baits should not be exposed to strong light for long periods of time. Some pheromone components are photosensitive and will degrade rapidly if left in bright light.

Traps should be serviced as often as possible. Frequent checking will prevent trap overloading and will facilitate identification of trapped specimens. It is suggested that traps be checked at least every two weeks unless other conditions suggest more frequent checking is necessary (i.e. traps overloaded or replacement of pheromone dispensers is required). Guidelines for handling collected specimens is covered in a separate section of this manual.

Volatility and degradation rates vary between pheromone components among the various species, and release characteristics are different for the different types of dispensers. For these reasons, no generalizations can be made about field life of baits. The expected field life and recommended intervals for bait replacement are listed for each individual species.

Placement of traps (i.e. height, crop) is also outlined for each individual species. Flight characteristics and response to pheromones vary from species to species; closely following these recommendations will maximize trap efficiency. Little or, in most cases, no work has been done on the optimal trap spacing for detection of these exotic pests. However, some general information is available about the flight ability and response to pheromone over distances for a few species.

TRAPPING DENSITY GUIDELINES

This section provides information for planning trapping programs and estimating their effectiveness. The procedure will assist in making trap density decisions, and standardize this decision making process among cooperators. The tables and graphs were derived from a hypergeometric distribution described extensively by Victor Beal (USDA, APHIS, VS) in his Regulatory Statistics Volumes. They can be used to estimate either the number of traps needed to detect a certain number of infested acres, or reversing this, the size of an infestation detectable with an available number of traps. Here we are defining an infestation as any density of an established reproducing pest. This kind of probability distribution has been used historically to design sampling schemes for cattle disease surveys and for inspecting imported commodities for pests. At large acreage, the number of traps needed to detect a particular infestation rate levels off (Figure 1). This is because, as the total acres being sampled increases towards infinity, non-replacement becomes less important and the hypergeometric distribution then asymptotically approaches a binomial distribution. Simply, in a large population of sampling units (fields, orchards, etc.) with a small number of samples, statistically it does not make a great deal of difference if sample units are replaced (i.e., put back in the pool of units from which samples are drawn).

The probabilities referred to here are based on random sampling. Under most circumstances, the random placement of traps would be a difficult proposition in exotic pest surveys. Placement using a grid pattern might be used for some cropping systems, however, a more reasonable alternative would be to calculate the number of traps to be placed in each county on a per acre basis (see example A below). Sites for individual trap placement within a county should then be selected to increase detection odds, i.e. areas with a higher likelihood of introduction (see Pathway Studies) or sites that would favor the establishment and buildup of a pest. It should be noted that these methods should be used only as a means of detecting an infestation and not to infer information about population densities.

The tables below were developed by Dr. Beal* using the following formula as an approximation of the actual hypergeometric distribution:

$$n = (N - d/2 + 1/2) - (1-p)^{(1/d)} \times (N - d/2 + 1/2)$$

or

$$d = (N - n/2 + 1/2) - (1-p)^{(1/n)} \times (N - n/2 + 1/2)$$

where n = sample size
d = number of infested units
N = total number of units to be surveyed
p = probability of detecting at least one infested unit

These variables are described below.

* Beal, B. C., Jr. 1973. REGULATORY STATISTICS - Appendix PART III Supplement in VOLUME 2-B; p. A-3-sup-3.

To maximize the chances of detecting an infestation, the location of each trap should be optimized. Trap locations should be selected on the basis of pathway information when available. Where possible, traps should be placed with a host crop of the target insect. Crops which are not sprayed will likely harbor larger populations of the target species and placement at these sites will enhance detection. When trapping two species with the same trap, placement of the trap where host plants are adjacent or in close proximity will be the most desirable location. Recommendations for combinations are listed under each individual species. When traps are hung within a crop, care should be exercised so that entry ports are not blocked by vegetation or, in some cases, blocked by the stake the trap is hung on. When servicing traps,any damaged traps, or traps that have the sticky surface saturated with insects, dirt of debris, should be replaced.

Table 1 is presented as a guide in allocating survey resources. It gives the national acreage of various crops, broken down by state. These data can be useful in determining the amount of trapping necessary in each state to determine the presence of a pest. Similar statistics for other crops are available in the "1982 Census of Agriculture, Vol. 2, Part 3, Ranking of State and Counties", U. S. Department of Commerce.

The intensity of trapping that is prescribed for a particular state will be a trade-off between the number of traps that can reasonably be maintained and the size of the infestation that will probably be detected. Placing large numbers of traps will result in infestations being small when first detected; superficial survey will, on the average, only detect infestations when they are large and extensive. Goals must be stated for each pest/crop which define the minimum size of infestation that the program intends to detect. It is generally prudent to assume that infestations will not be detected unless the trap is placed in an infestation (i.e., moths will not fly great distances to trap sites). While this is not necessarily always true, it is a conservative assumption. Furthermore, only commercial production areas are considered in Table 1 and there may be reasons to expand the trapping program to include, or focus on, noncommercial (ornamental) situations that offer a high likelihood of introduction (such as port of entry environs along international borders or in residential areas).

The probability of detecting an infestation is influenced by the number of acres susceptible to a given pest, the number of acres infested by the target insect and the number of samples (traps placed). Trap efficiency, flight and dispersal behavior, and pest population density also factor into determining detection probability. A working knowledge of where and how the particular insect is likely to be introduced (pathway studies) will also enhance the detection program.

In the following section, a statistical approach is presented to assist in planning an effective trapping program.

Four pieces of information are required to estimate either the number of traps needed to achieve a desired detection efficiency, or the survey effectiveness with a known number of traps:

1. **Unit of a Trap's Active Area (UTAA)** - defined as the area around a trap in which its trapping efficiency is 100%. The limits of the active area are species specific, and regulated by insect behavior and trap characteristics. The major assumption is that within the UTAA the trap will capture at least one insect when any density of the pest is present. This does not consider insects randomly moving into the UTAA as this movement is species dependent and has not been defined for the target insects. We suggest that in the absence of trapping efficiency data (which is the case for species in the exotic survey project), the UTAA can conservatively be estimated as one acre.

2. **Total number of trap units to be surveyed (N)** - This value might be the total area of target host plants in a state, or in the case of a high risk urban area, simply land area.

3. Either: **The minimal number of infested trap units to be detected (d)** - The infested area could be concentrated in one location, i.e. one orchard or numerous small infestations scattered throughout the survey area. This number can be converted to an infestation rate by dividing the number of infested units to be detected by the total number of trap units to be surveyed.

   Or: The number of available traps (n)

4. **Probability (p)** - under which we would detect at least one unit of infestation, i.e. 90, 95 or 99%.

The following examples explain the use of these tables:

Example A

Question: How many traps should be placed to detect 100 acres (or more) infested by *Adoxophyes orana* in 10,000 acres of commercial orchards at a 99% level of confidence?

Pest: Adoxophyes orana
UTAA: one acre
Total acres (N): 10,000 acres of commercial orchard
Minimal infestation (d): 100 acres or a 1% (100/10,000) infestation rate
Confidence Level (p): 99%

From the 99% probability, Table 4, we can determine the number of traps to be used by following the 1% infestation column down to the 10,000 total units row, in this case, 448 traps or one trap for every 22 acres (10,000/448). In a county with 100 acres of apples for example, we would place 5 traps. Within the county, we can increase the odds of detection by using experience in the individual trap placement, i.e. in the case of *Adoxophyes orana*, next to, or in abandoned orchards.

Example B

Question: If 50 traps are available to survey 20,000 acres of apples for *Adoxophyes orana*, what rate of infestation can we detect at a 90% level of confidence?

Pest: *Adoxophyes orana*
UTAA: two acres (note that this is twice the size of the UTAA in Example A)
Total Acres (N): 20,000 or 10,000 UTAA
Traps (n): 50
Confidence (p): 90%

By reversing the procedure in Example 1 and using the 90% Table 2, we can say that 50 traps will detect at a 5% infestation rate, or 500 infested UTAAs or 1,000 acres.

Table 1. Acres (in thousands) of various crops planted in the United States. Statistics are only provided for the leading states, which, in most cases, account for 90% of the total acreage. Values are taken from the "1982 Census of Agriculture, Ranking of States and Counties," U.S. Department of Commerce.

	AL	AR	AZ	AK	CA	CO	CT	DE	FL	GA	HI	ID	IL	IN	IA	KS	KY	LA	ME	MD	MA	MI	MN	MS	MO
falfa					845	690						968	570		1535	876						950	1652		486
ple					30	6.8						8.4	9.2	6.0					7.6	7.1	8.4	70			
rry					12							.9										65			
n						760				788			1138	5975	12880	1162	1343			620		2569	5904		1893
tton	295	405	518		1313					131								563						978	
apes		2.5	3.7		757																	13			1.5
apefruit			7.6		19				166																
ange			14		172				706									.5							
ach	5.2	3.7			74	2.4			1.5	23		.9								3.4		10			3.8
ar					31	.8	.3					.3										2.3			
ums			.8		122	.2						1.2										4.2			
ce		1263			567													573						240	
rghum	50	236	12		52	308				94			110			3187	30	116						89	747
ybeans	1589	4199								2024			8998	4397	8044	1692	1462	2638				1123	4502	3459	5286
acco										45							257			25					
etable			63		794			37	248	60		42	80							37		120	176		
at		1668			929	2850				996		1508	1453	893		11664							2972	809	2045
ley			36		583	196						1091								72		35	827		
s					50					66			177	95	812	169						399	1290		

	MT	NE	NV	NH	NJ	NM	NY	NC	ND	OH	OK	OR	PA	RI	SC	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY	Leading States TOTAL	U.S. TOTAL
alfa	1329	1392					901		1357				755			1996			462			396		2678		20,829	23,917
le					7.7		78	19		15		12	39							4.9	30	146	19	10.4		533	591
rry	1.3						8.5					17	2.7						4.7			14		4.2		131	134
n		6519					749	1393		3863			1282			2583		1097			611			3257		66,633	69,858
ton											414						242	4523								9,383	9,781
pes							43			3.1		2.6	12									27				864	875
pefruit																		48								241	241
nge																		26								919	919
ch					14		3				2.1	1.8	12		40			9.8			4.9	2.8	3.6			223	248
r							3.6					20	1.5						.4			21				81	85
ms							1			.2		5.3	.4									2.3				138	140
e																		521								3,164	3,233
ghum		1657				259		42			468				19	263	67	4812								12,617	12,679
beans		2106						1747		3633					1386	769	2104	720								61,878	64,833
acco								338		14			12		60		82									907	932
etable					68		155	53		52		134	46		31			205				168		274		2,845	3,143
at	5216	2585							9819	1151	5972	1180				3332		5087				2716				64,851	70,910
ley	1614		28			32		62	1809			250	59			522			151		86	752		48	137	8,389	8,650
s	168	397					250	53	964	304	82	76	307			1807		264						891		8,620	9,131

Table 2. 90% Probability.
Number of traps required to detect an infestation at eleven infestation rates (10% to .05%) in a total number of trap units ranging from 100 to 900,000 and at a confidence level of 90%. Listed are the number of infested units detectable and the number of traps required.

Total Units	Infestation Rate (# of Trap Units Infested/Total Trap Units)																					
	10%		7.5%		5%		2.5%		1%		0.75%		0.5%		0.25%		0.1%		0.075%		0.05%	
N	Units	Traps	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n
100	10	20	8	26	5	36	3	60	1	90												
200	20	21	15	27	10	40	5	73	2	136	2	157	1	180								
300	30	21	23	28	15	42	8	78	3	160	2	192	2	235								
400	40	21	30	28	20	42	10	81	4	174	3	214	2	273	1	360						
500	50	21	38	29	25	43	13	83	5	184	4	229	3	300	1	421						
600	60	21	45	29	30	43	15	84	6	190	5	240	3	321	2	471						
700	70	22	53	29	35	43	18	85	7	195	5	248	4	337	2	512						
800	80	22	60	29	40	44	20	86	8	199	6	254	4	349	2	547						
900	90	22	68	29	45	44	23	87	9	202	7	259	5	360	2	576						
1,000	100	22	75	29	50	44	25	87	10	205	8	263	5	368	3	601	1	900				
2,000	200	22	150	29	100	44	50	89	20	216	15	284	10	410	5	737	2	1,367	2	1,569	1	1,800
3,000	300	22	225	29	150	45	75	90	30	221	23	291	15	426	8	792	3	1,607	2	1,921	2	2,353
4,000	400	22	300	29	200	45	100	90	40	223	30	294	20	434	10	822	4	1,750	3	2,143	2	2,735
5,000	500	22	375	29	250	45	125	90	50	224	38	297	25	439	13	840	5	1,844	4	2,294	3	3,009
6,000	600	22	450	29	300	45	150	90	60	225	45	298	30	442	15	853	6	1,911	5	2,402	3	3,215
7,000	700	22	525	29	350	45	175	90	70	225	53	299	35	445	18	862	7	1,961	5	2,485	4	3,374
8,000	800	22	600	29	400	45	200	90	80	226	60	300	40	446	20	869	8	2,000	6	2,549	4	3,501
9,000	900	22	675	30	450	45	225	90	90	226	68	301	45	448	23	874	9	2,031	7	2,600	5	3,604
10,000	1,000	22	750	30	500	45	250	91	100	227	75	301	50	449	25	879	10	2,056	8	2,643	5	3,690
20,000	2,000	22	1,500	30	1,000	45	500	91	200	228	150	304	100	454	50	899	20	2,174	15	2,845	10	4,113
30,000	3,000	22	2,250	30	1,500	45	750	91	300	228	225	304	150	456	75	906	30	2,215	23	2,917	15	4,268
40,000	4,000	22	3,000	30	2,000	45	1,000	91	400	228	300	305	200	457	100	909	40	2,236	30	2,954	20	4,349
50,000	5,000	22	3,750	30	2,500	45	1,250	91	500	229	375	305	250	457	125	911	50	2,249	38	2,977	25	4,398
60,000	6,000	22	4,500	30	3,000	45	1,500	91	600	229	450	305	300	458	150	913	60	2,258	45	2,992	30	4,432
70,000	7,000	22	5,250	30	3,500	45	1,750	91	700	229	525	305	350	458	175	914	70	2,264	53	3,003	35	4,456
80,000	8,000	22	6,000	30	4,000	45	2,000	91	800	229	600	305	400	458	200	915	80	2,269	60	3,011	40	4,474
90,000	9,000	22	6,750	30	4,500	45	2,250	91	900	229	675	305	450	458	225	915	90	2,272	68	3,017	45	4,488
100,000	10,000	22	7,500	30	5,000	45	2,500	91	1,000	229	750	305	500	458	250	916	100	2,275	75	3,022	50	4,500
200,000	20,000	22	15,000	30	10,000	45	5,000	91	2,000	229	1,500	306	1,000	459	500	918	200	2,288	150	3,046	100	4,551
300,000	30,000	22	22,500	30	15,000	45	7,500	91	3,000	229	2,250	306	1,500	459	750	918	300	2,293	225	3,053	150	4,569
400,000	40,000	22	30,000	30	20,000	45	10,000	91	4,000	229	3,000	306	2,000	459	1,000	919	400	2,295	300	3,057	200	4,578
500,000	50,000	22	37,500	30	25,000	45	12,500	91	5,000	229	3,750	306	2,500	459	1,250	919	500	2,296	375	3,060	250	4,583
600,000	60,000	22	45,000	30	30,000	45	15,000	91	6,000	229	4,500	306	3,000	459	1,500	919	600	2,297	450	3,061	300	4,586
700,000	70,000	22	52,500	30	35,000	45	17,500	91	7,000	229	5,250	306	3,500	459	1,750	919	700	2,298	525	3,062	350	4,589
800,000	80,000	22	60,000	30	40,000	45	20,000	91	8,000	229	6,000	306	4,000	459	2,000	919	800	2,298	600	3,063	400	4,591
900,000	90,000	22	67,500	30	45,000	45	22,500	91	9,000	229	6,750	306	4,500	459	2,250	919	900	2,299	675	3,064	450	4,592

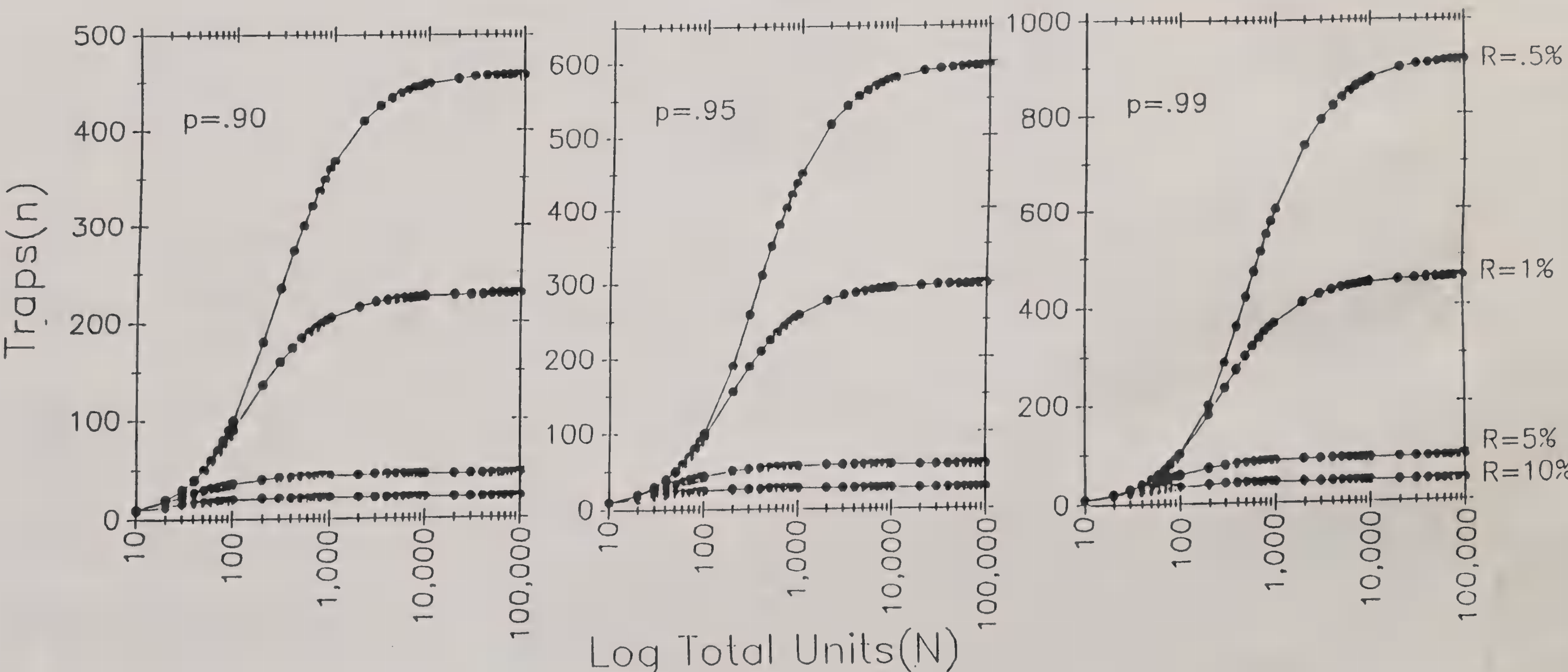
Table 3. 95% Probability.
Number of traps required to detect an infestation at eleven infestation rates (10% to .05%) in a total number of trap units ranging from 100 to 900,000 and at a confidence level of 95%. Listed are the number of infested units detectable and the number of traps required.

Total Units	Infestation Rate (# of Trap Units Infested/Total Trap Units)																					
	10%		7.5%		5%		2.5%		1%		0.75%		0.5%		0.25%		0.1%		0.075%		0.05%	
N	Units	Traps	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n
100	10	25	8	32	5	44	3	69	1	95												
200	20	27	15	35	10	51	5	89	2	155	2	173	1	190								
300	30	27	23	36	15	53	8	98	3	189	2	220	2	259								
400	40	27	30	37	20	54	10	102	4	210	3	252	2	310	1	380						
500	50	28	38	37	25	55	13	105	5	224	4	274	3	349	1	454						
600	60	28	45	37	30	56	15	107	6	235	5	291	3	378	2	518						
700	70	28	53	37	35	56	18	109	7	243	5	303	4	402	2	573						
800	80	28	60	38	40	56	20	110	8	249	6	313	4	421	2	621						
900	90	28	68	38	45	57	23	111	9	254	7	322	5	437	2	662						
1,000	100	28	75	38	50	57	25	112	10	258	8	328	5	450	3	698	1	950				
2,000	200	28	150	38	100	58	50	115	20	277	15	361	10	517	5	901	2	1,552	2	1,728	1	1,900
3,000	300	28	225	38	150	58	75	116	30	284	23	373	15	542	8	987	3	1,894	2	2,207	2	2,593
4,000	400	28	300	38	200	58	100	117	40	287	30	379	20	555	10	1,034	4	2,108	3	2,526	2	3,105
5,000	500	28	375	38	250	58	125	117	50	289	38	382	25	563	13	1,064	5	2,253	4	2,750	3	3,491
6,000	600	28	450	38	300	58	150	117	60	291	45	385	30	569	15	1,085	6	2,357	5	2,916	3	3,789
7,000	700	28	525	38	350	58	175	117	70	292	53	387	35	573	18	1,100	7	2,436	5	3,043	4	4,025
8,000	800	28	600	38	400	58	200	117	80	293	60	388	40	576	20	1,112	8	2,498	6	3,143	4	4,216
9,000	900	28	675	38	450	58	225	118	90	293	68	389	45	578	23	1,121	9	2,547	7	3,225	5	4,374
10,000	1,000	28	750	38	500	58	250	118	100	294	75	390	50	580	25	1,128	10	2,587	8	3,292	5	4,506
20,000	2,000	28	1,500	38	1,000	58	500	118	200	296	150	394	100	589	50	1,162	20	2,781	15	3,619	10	5,176
30,000	3,000	28	2,250	38	1,500	58	750	118	300	297	225	395	150	592	75	1,173	30	2,850	23	3,738	15	5,430
40,000	4,000	28	3,000	38	2,000	58	1,000	118	400	297	300	396	200	593	100	1,179	40	2,885	30	3,800	20	5,563
50,000	5,000	28	3,750	38	2,500	58	1,250	118	500	297	375	396	250	594	125	1,183	50	2,906	38	3,838	25	5,645
60,000	6,000	28	4,500	38	3,000	58	1,500	118	600	297	450	397	300	595	150	1,185	60	2,921	45	3,863	30	5,701
70,000	7,000	28	5,250	38	3,500	58	1,750	118	700	297	525	397	350	595	175	1,187	70	2,931	53	3,881	35	5,741
80,000	8,000	28	6,000	38	4,000	58	2,000	118	800	298	600	397	400	595	200	1,188	80	2,939	60	3,895	40	5,771
90,000	9,000	28	6,750	38	4,500	58	2,250	118	900	298	675	397	450	596	225	1,189	90	2,945	68	3,906	45	5,795
100,000	10,000	28	7,500	38	5,000	58	2,500	118	1,000	298	750	397	500	596	250	1,190	100	2,950	75	3,914	50	5,814
200,000	20,000	28	15,000	38	10,000	58	5,000	118	2,000	298	1,500	398	1,000	597	500	1,193	200	2,972	150	3,953	100	5,901
300,000	30,000	28	22,500	38	15,000	58	7,500	118	3,000	298	2,250	398	1,500	597	750	1,194	300	2,979	225	3,966	150	5,931
400,000	40,000	28	30,000	38	20,000	58	10,000	118	4,000	298	3,000	398	2,000	597	1,000	1,195	400	2,983	300	3,973	200	5,945
500,000	50,000	28	37,500	38	25,000	58	12,500	118	5,000	298	3,750	398	2,500	597	1,250	1,195	500	2,985	375	3,977	250	5,954
600,000	60,000	28	45,000	38	30,000	58	15,000	118	6,000	298	4,500	398	3,000	597	1,500	1,196	600	2,987	450	3,980	300	5,960
700,000	70,000	28	52,500	38	35,000	58	17,500	118	7,000	298	5,250	398	3,500	597	1,750	1,196	700	2,988	525	3,981	350	5,964
800,000	80,000	28	60,000	38	40,000	58	20,000	118	8,000	298	6,000	398	4,000	597	2,000	1,196	800	2,989	600	3,983	400	5,968
900,000	90,000	28	67,500	38	45,000	58	22,500	118	9,000	298	6,750	398	4,500	597	2,250	1,196	900	2,989	675	3,984	450	5,970

Table 4. 99% Probability.
Number of traps required to detect an infestation at eleven infestation rates (10% to .05%) in a total number of trap units ranging from 100 to 900,000 and at a confidence level of 99%. Listed are the number of infested units detectable and the number of traps required.

Total Units	Infestation Rate (# of Trap Units Infested/Total Trap Units)										
	10%	7.5%	5%	2.5%	1%	0.75%	0.5%	0.25%	0.1%	0.075%	0.05%
N	Units Traps	d n	d n	d n	d n	d n	d n	d n	d n	d n	d n
100	10 35	8 44	5 59	3 84	1 99						
200	20 39	15 51	10 72	5 119	2 180	2 190	1 198				
300	30 41	23 54	15 77	8 136	3 235	2 261	2 286				
400	40 41	30 55	20 80	10 146	4 272	3 313	2 360	1 396			
500	50 42	38 56	25 82	13 152	5 300	4 353	3 420	1 487			
600	60 42	45 56	30 83	15 157	6 320	5 383	3 470	2 572			
700	70 42	53 57	35 84	18 160	7 336	5 408	4 511	2 649			
800	80 43	60 57	40 85	20 163	8 349	6 427	4 546	2 720			
900	90 43	68 57	45 85	23 165	9 359	7 444	5 575	2 783			
1,000	100 43	75 57	50 86	25 166	10 367	8 457	5 601	3 841	1 990		
2,000	200 43	150 58	100 88	50 174	20 409	15 527	10 736	5 1,203	2 1,800	2 1,907	1 1,980
3,000	300 43	225 59	150 88	75 176	30 425	23 553	15 791	8 1,375	3 2,353	2 2,612	2 2,861
4,000	400 44	300 59	200 89	100 178	40 433	30 567	20 821	10 1,475	4 2,734	3 3,137	2 3,600
5,000	500 44	375 59	250 89	125 179	50 438	38 576	25 839	13 1,539	5 3,008	4 3,535	3 4,207
6,000	600 44	450 59	300 89	150 179	60 441	45 582	30 852	15 1,584	6 3,214	5 3,843	3 4,707
7,000	700 44	525 59	350 89	175 180	70 443	53 586	35 861	18 1,618	7 3,373	5 4,087	4 5,121
8,000	800 44	600 59	400 89	200 180	80 445	60 589	40 868	20 1,643	8 3,500	6 4,285	4 5,469
9,000	900 44	675 59	450 89	225 180	90 447	68 591	45 873	23 1,664	9 3,603	7 4,449	5 5,764
10,000	1,000 44	750 59	500 89	250 180	100 448	75 593	50 878	25 1,680	10 3,689	8 4,587	5 6,018
20,000	2,000 44	1,500 59	1,000 90	500 181	200 453	150 602	100 898	50 1,758	20 4,111	15 5,285	10 7,379
30,000	3,000 44	2,250 59	1,500 90	750 181	300 455	225 606	150 905	75 1,784	30 4,267	23 5,551	15 7,929
40,000	4,000 44	3,000 59	2,000 90	1,000 181	400 456	300 607	200 908	100 1,798	40 4,348	30 5,690	20 8,225
50,000	5,000 44	3,750 59	2,500 90	1,250 182	500 456	375 608	250 910	125 1,806	50 4,397	38 5,776	25 8,410
60,000	6,000 44	4,500 59	3,000 90	1,500 182	600 456	450 609	300 912	150 1,812	60 4,431	45 5,834	30 8,536
70,000	7,000 44	5,250 59	3,500 90	1,750 182	700 457	525 609	350 913	175 1,816	70 4,455	53 5,876	35 8,628
80,000	8,000 44	6,000 59	4,000 90	2,000 182	800 457	600 609	400 913	200 1,819	80 4,473	60 5,908	40 8,698
90,000	9,000 44	6,750 59	4,500 90	2,250 182	900 457	675 610	450 914	225 1,821	90 4,487	68 5,933	45 8,753
100,000	10,000 44	7,500 59	5,000 90	2,500 182	1,000 457	750 610	500 915	250 1,823	100 4,499	75 5,953	50 8,797
200,000	20,000 44	15,000 59	10,000 90	5,000 182	2,000 458	1,500 611	1,000 917	500 1,831	200 4,550	150 6,045	100 8,999
300,000	30,000 44	22,500 59	15,000 90	7,500 182	3,000 458	2,250 611	1,500 917	750 1,834	300 4,568	225 6,076	150 9,068
400,000	40,000 44	30,000 59	20,000 90	10,000 182	4,000 458	3,000 611	2,000 918	1,000 1,836	400 4,576	300 6,091	200 9,103
500,000	50,000 44	37,500 59	25,000 90	12,500 182	5,000 458	3,750 611	2,500 918	1,250 1,836	500 4,582	375 6,100	250 9,124
600,000	60,000 44	45,000 59	30,000 90	15,000 182	6,000 458	4,500 611	3,000 918	1,500 1,837	600 4,585	450 6,107	300 9,138
700,000	70,000 44	52,500 59	35,000 90	17,500 182	7,000 458	5,250 611	3,500 918	1,750 1,837	700 4,588	525 6,111	350 9,148
800,000	80,000 44	60,000 59	40,000 90	20,000 182	8,000 458	6,000 612	4,000 918	2,000 1,838	800 4,590	600 6,114	400 9,155
900,000	90,000 44	67,500 59	45,000 90	22,500 182	9,000 458	6,750 612	4,500 918	2,250 1,838	900 4,591	675 6,117	450 9,161

Figure 1. Hypergeometric distribution at four infestation rates (R) and three probabilities (R=Units Infested(d)/Total Units(N)).



PROCEDURES FOR IDENTIFICATION AND REMOVAL OF INSECT SPECIMENS FROM STICKY TRAPS

Removal of insect specimens from sticky traps in a condition suitable for subsequent examination with a microscope is sometimes desirable. This can be done with little difficulty for many groups of insects, particularly those with hard exoskeletons, such as beetles and wasps. Successful removal of soft-bodied or scaly insects, such as aphids and caddisflies, is more difficult and is virtually impossible with certain groups, such as moths. Moths cannot be removed without seriously damaging the scale patterns which are the characters generally used as the first step in identification. For moths, it is best to attempt identification, or provide the identifier with the specimen(s) in place on the sticky trap (either the entire trap or the part bearing the moth(s) being cut out). If identification cannot be made in this way, it may be appropriate to dissolve the moths from the sticky material and examine the genitalia. Such specimens may be identified by examining the abdomen, i.e., the genitalia, which can be carefully removed, cleaned according to the following methods, and preserved.

Polyisobutylene is the most widely used sticky material in sticky traps. This material is non-polar and is thus poorly dissolved by a polar solvent such as acetone. Effective and preferred materials for specimen removal are toluene, heptane, hexane, xylene, and ethyl acetate, all of which can be readily obtained. Solvents for occasional use and which are also readily available are fingernail polish remover (ethyl acetate) and a solvent-cleaner, methyl chloroform (1,1,1=trichloroethane) (the current replacement for carbon tetrachloride). Petroleum spirits is effective but leaves a short-term residue, whereas gasoline or kerosene will linger on the specimens for days or weeks and are not preferred. SINCE ALL OF THESE SOLVENTS ARE FLAMMABLE AND ARE TOXIC TO HUMANS TO SOME EXTENT, THEY SHOULD BE HANDLED OUTDOORS OR UNDER A HOOD.

Another solvent which may be used for removing insects from the sticky material in traps is Histo-clear[1]. It is a mixture of corn and citrus oil distillates and is regarded by the FDA as safe, giving it an advantage over the other solvents previously described. Insects can be removed from trap surfaces by soaking in Histo-clear for 5-10 minutes. Specimens soaked in Histo-clear will be brittle; the longer the soaking time the more brittle. Specimens may be preserved by placing in 70% ethanol. Histo-clear, manufactured by National Diagnostics[1], is a clearing agent and wings will appear almost transparent after soaking in it.

A decision must be made as to the number of specimens to be removed from the sticky trap. If a general survey is intended, the entire trap may be immersed in the solvent until the sticky material is dissolved. The solvent is then drained off, leaving the intact insects behind for further treatment as described below. If only a few insects are to be removed, selected pieces of the trap may be cut out and immersed in the solvent to free the specimens. <u>In each method, the insects should be immersed until free of the sticky material but no longer, as the solvents have a tendency to make the specimens brittle</u>.

After all of the sticky material has been dissolved from the specimens, they must be washed in Cellosolve\ and then xylene to remove the solvent. Immerse the specimens in a bath of Cellosolve for an hour or longer to remove the solvent, replacing the Cellosolve after half an hour if many specimens are processed simultaneously. The specimens may safely be left overnight in Cellosolve. The Cellosolve should then be drained off and replaced with xylene for one-half to one hour. <u>CAUTION: all insects become brittle and some are permanently damaged by prolonged immersion in xylene</u>. The specimens may then be placed on absorbent paper and dried. If they are manipulated with fine insect pins or a camel's hair brush while drying, the wings, body hairs and bristles will assume their natural positions. The specimens may then be carefully point-mounted or glued to the side of a pin and labelled.

EXOTIC PEST DETECTION SURVEY RECOMMENDATIONS

Adoxophyes orana   Summer fruit tortrix moth

Hosts: Apple, Pear, Peach, Strawberry

Distribution: See map

Biology: Adoxophyes orana is a bivoltine tortricid which overwinters as 2nd or 3rd instar larvae in bud axiles, bark crevices and under dry leaves. Diapause is induced by short (less than 12-hour) day length. In the Netherlands, diapause is normally initiated in late September or early October. Diapausing larvae can survive the low winter temperature of Northern Europe.

Overwintering larvae begin feeding in the spring after an accumulation of approximately 67 degree-days C (ddC) (in Romania) based on a 9°C developmental threshold. These larvae feed on the leaves and flowers of the host plants and pupate in May. In France, adult moths emerge during the first part of June, with oviposition shortly thereafter. Second generation adults emerge in mid-August. Flight occurs at temperatures above 13°C. The summer generation of larvae lasts, on average, 430 ddC above a threshold of 7°C in France, and feed mainly on the leaves. Second generation larvae feed on fruit before entering diapause in the fall.

Up to 10% and 20% fruit loss has occurred in France and Germany, respectively.

Potential U.S. distribution: Throughout the US, wherever host plants occur (see map).

Recommended survey areas: Major apple and pear producing areas (see map). WA, NY, MI, CA, PA, VA, NC, WV, OR, NJ, IL, MA, ME, ID, CO, MD, OH, MO, NH, WI, IN, UT, VT, CT

Pheromone: 90:10:10:2 mixture of (Z)-9-Tetradecen-1-ol acetate (of high isomeric purity), (Z)-11-Tetradecen-1-ol acetate, (Z)-9-Tetradecen-1-ol, (Z)-11-Tetradecen-1-ol.
dispenser type - polycap, rubber septa
field life - 2 months, if a longer trapping period than 2 months is anticipated, replace baits at midseason.

Commercial source of pheromone dispensers: United Agri Products Co., Trece Corp.

Traps: USDA delta trap with ends open (i.e. the ends of the trap which are normally folded in to form a small triangular entry port, should not be folded); Wing Trap

Trap placement: Within apple or pear orchards, suspended from the limbs of trees ca. 1.5 m in height.

Recommended combinations: None presently recommended. *A. orana* pheromone is, in fact, a powerful inhibitor to many other species. Contamination of other traps should be carefully avoided. (E)-9-14:A is a powerful inhibitor to *A. orana* attraction.

Non-target species that may be captured:

Argyrotaenia velutinana
Choristoneura rosaceana
Grapholita molesta
Pandemis limitata
Pandemis pyrusana

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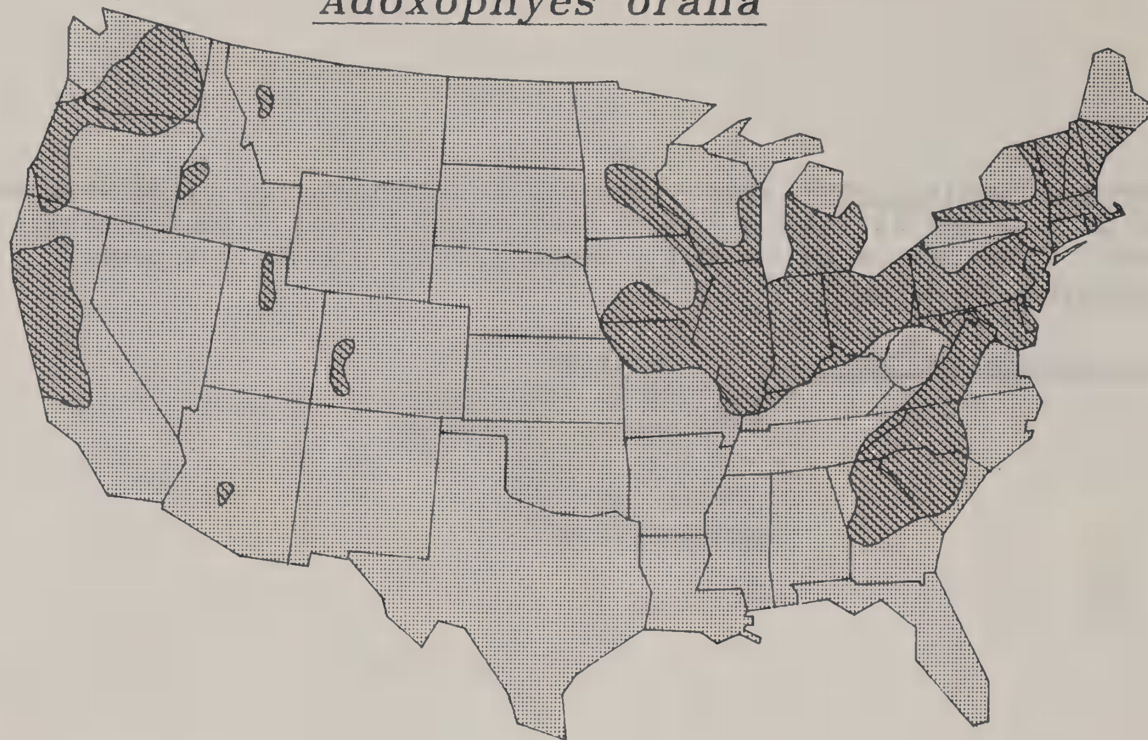
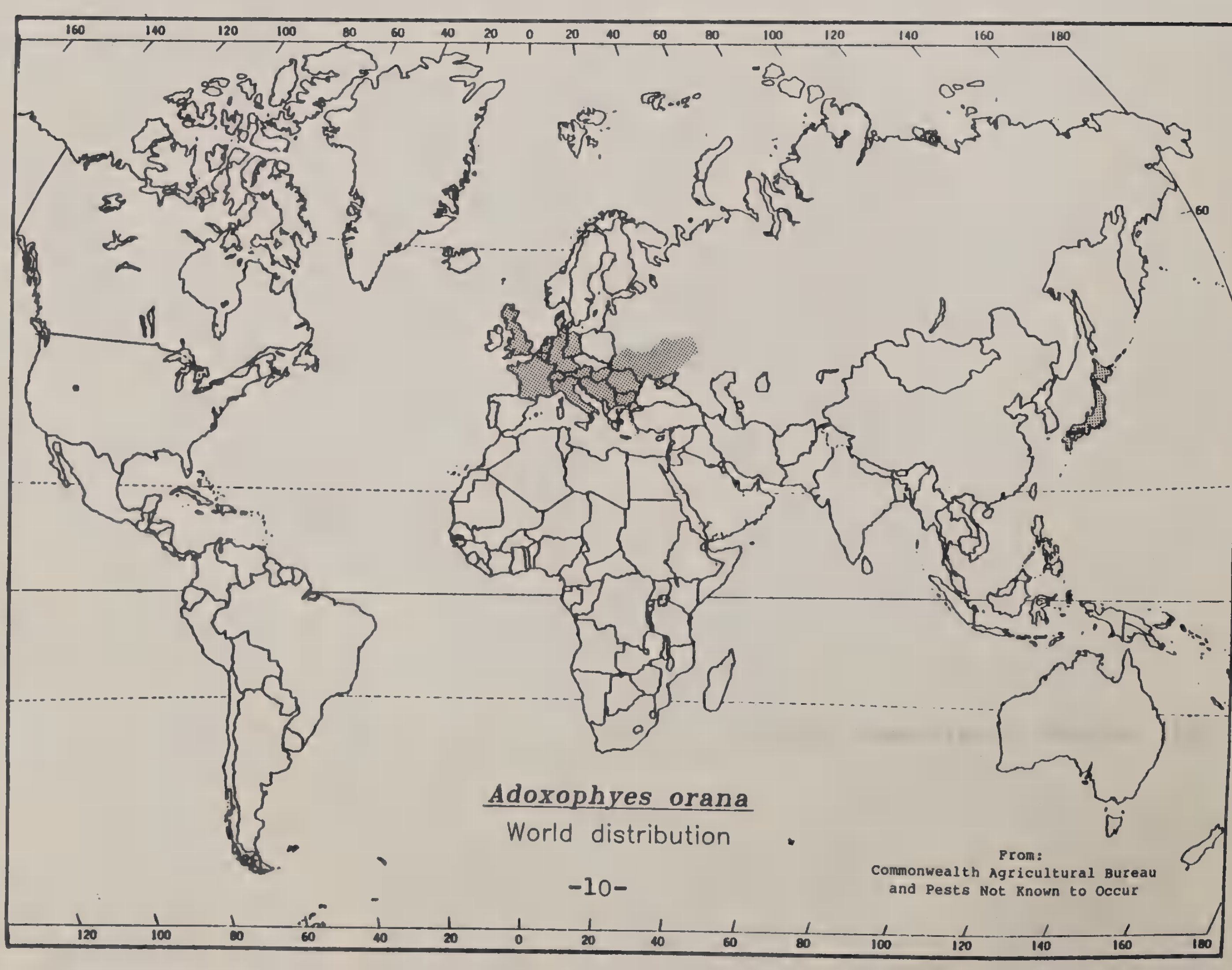
Adoxophyes orana



Major host growing areas
(see attached maps for additional detail)

Potential ecological range



Adoxophyes orana
World distribution

From:
Commonwealth Agricultural Bureau
and Pests Not Known to Occur

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EXOTIC PEST DETECTION SURVEY RECOMMENDATIONS

Autographa gamma Silver Y moth

Hosts: Most cultivated crops including potatoes, beets, peas, crucifers and other legumes, cereals, flax, hemp and grasses and even forest trees.

Distribution: See map

Biology: Eggs are laid either singly or in small clusters on the underside of leaves. Larvae feed on leaves and pupate in off-white cocoons on the host plant. There are usually two generations per year with overwintering in the cocoon.

Potential U.S. Distribution: Throughout the U.S.

Recommended Survey Areas: Because this pest can cause severe damage on many crops and can potentially occur throughout the U.S., we are not designating specific states to be surveyed but suggest trapping in major truck farming areas.

Pheromone: 100:1 mixture of (Z)-7-Dodecen-1-ol acetate:(Z)-7-Dodecen-1-ol
loading rate - 1.0 mg
dispenser type - rubber septa
field life - 30 days - replace baits every 30 days.

Source of Pheromone Dispensers: Otis Methods Development Center.

Traps: United Agri Products and Trece Wing Traps

Trap Placement: Within or on the edge of fields of host crops. Traps should be suspended from stakes and placed at the level of the crop height and raised as the crop matures.

Recommended Combinations: None presently recommended.

Non-target species that may be captured:

Noctuidae:	Anagrapha ampla	Autographa ampla
	Autographa biloba	Autographa californica
	Caenurgina spp.	Lacanobia lutra
	Lacinipolia renigera	Polias spp.
	Pseudoplusia includens	Rachiplusia ou
	Spodoptera ornithogalli	Syngrapha falcifera
Pieridae:	Pieris rapae	
Pterophoridae:	Geina periscelidactyla	
Pyralidae	Ostrinia nubilalis	Helvibotys helvialis
Tortricidae:	Episemus argutanus	

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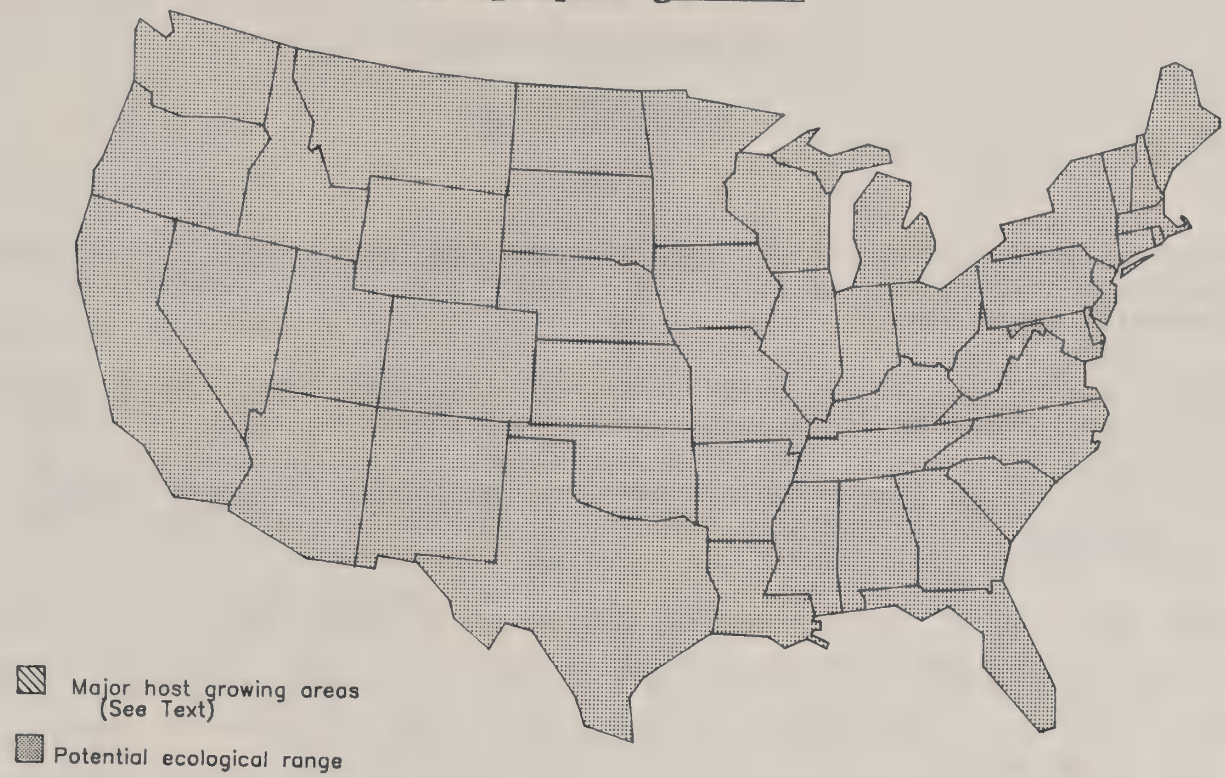
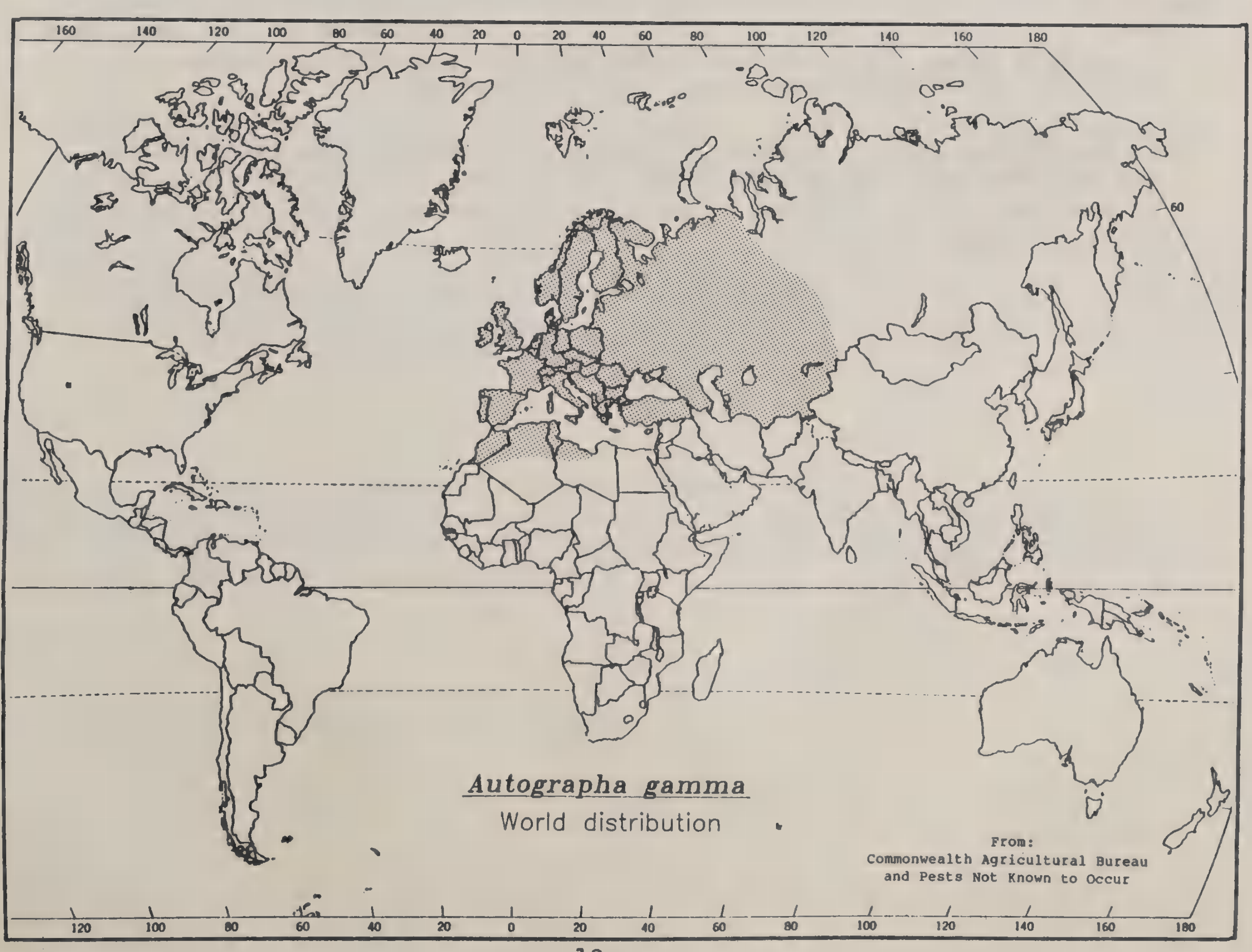
Autographa gamma





Autographa gamma
World distribution

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for
Autographa gamma

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<u>Chilo partellus</u> Maize borer

<u>Hosts</u>: Corn, sorghum

<u>Distribution</u>: See map

<u>Biology</u>: Adult moths are nocturnal and lay eggs near the leaf-base. Small larvae feed on the leaf whorl or mine leaves, while later instars bore into the stalks or ears. Pupation takes place in the stems or stalks. This species is multivoltine with up to seven generations per year in India. Mature larvae overwinter in stalks, stubble or in the ears of corn.

<u>Potential U.S. Distribution</u>: *

<u>Recommended Survey Areas</u>: Major corn and sorghum producing states within the proposed ecological range of pest. CA, AZ, TX, LA, MS, AL, GA, SC, NC

<u>Pheromone</u>: (Z)-11-Hexadecenal
loading rate - 500 ug + 500 ug BHT (antioxidant)
dispenser type - rubber septa "extracted" or polyvials.
field Life - 30 days - replace baits every 30 days.

<u>Sources of Pheromone Dispensers</u>: Raylo Chemicals Ltd., Otis Methods Development Center.

<u>Traps</u>: United Agri Products and Trece Wing Trap

<u>Trap Placement</u>: Within fields of host crops. Traps should be suspended from stakes just below the crop height and raised as the crop matures.

<u>Recommended Combinations</u>: None

<u>Non-target species that may be captured</u>:
Noctuidae: <u>Heliothis zea</u>
Ctenuchidae: <u>Cisseps fulvicollis</u>

* The potential ecological range of this pest is in question since information regarding its northern limit is presently lacking or confused because of taxonomic problems. The proposed map is simply a "best guess" until more data are available.

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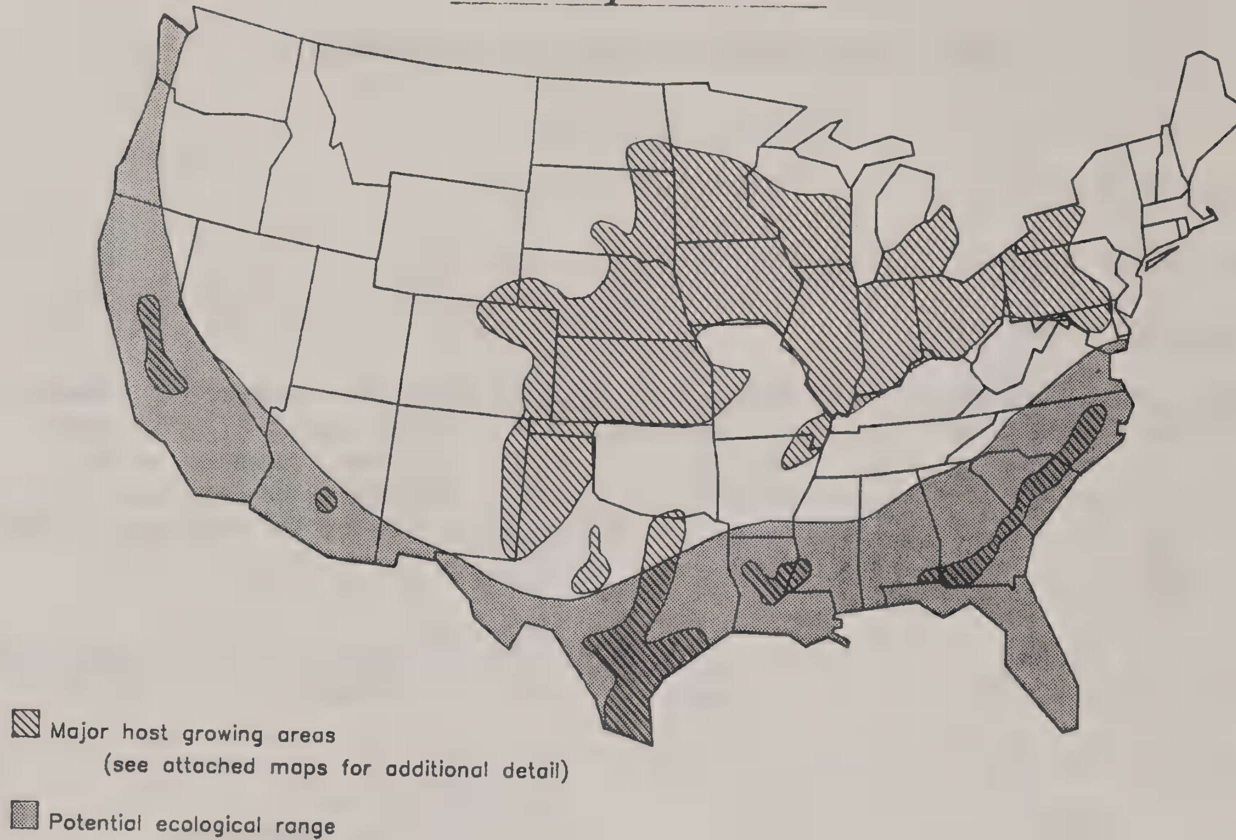
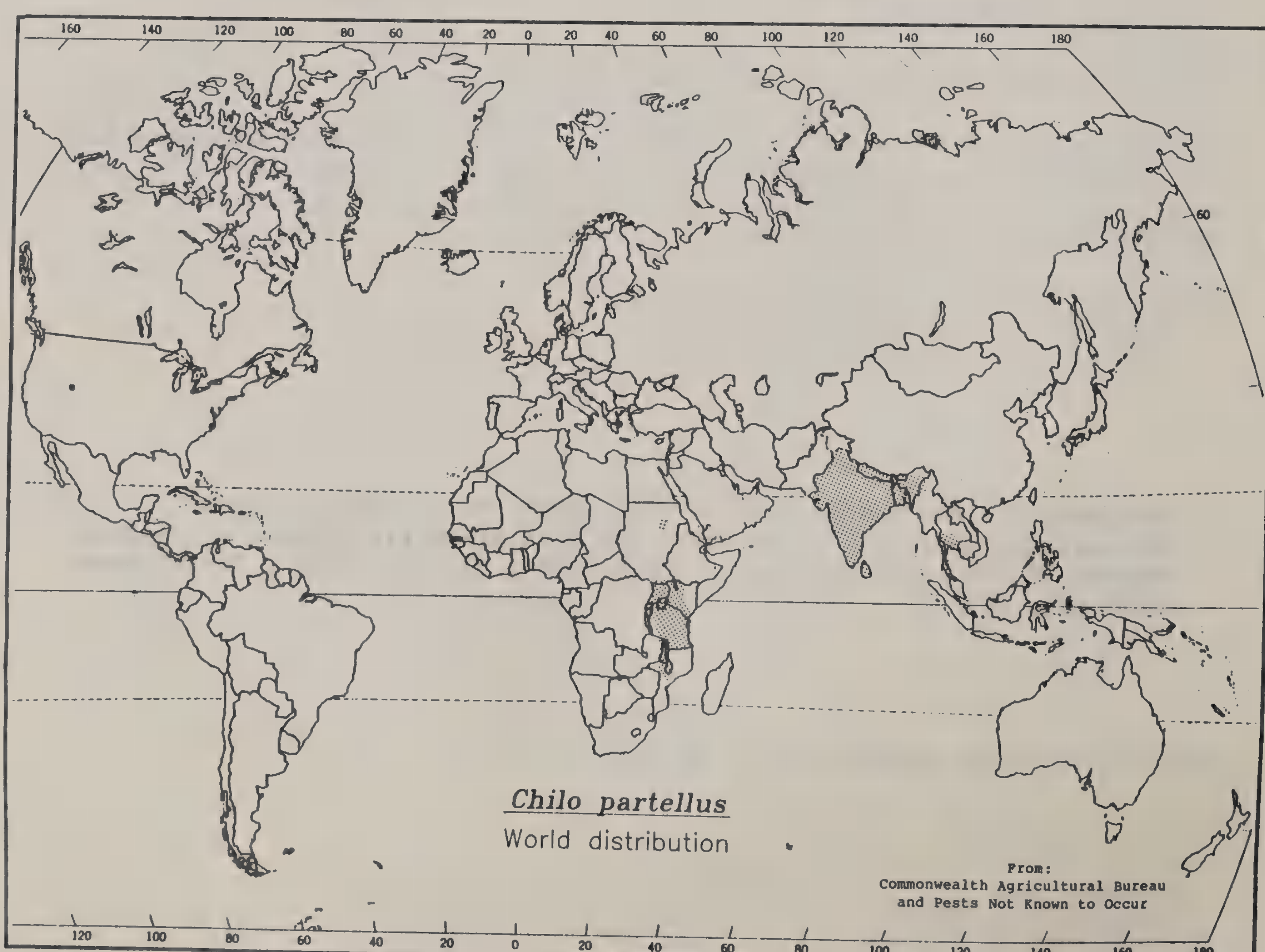
Chilo partellus





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for
Chilo partellus

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Chilo suppressalis Asiatic rice borer

Hosts: Several grasses including corn but rice is most severely damaged.

Distribution: See map

Biology: The biology of this moth is similar to that of *C. partellus*. Adults are nocturnal and lay eggs in clusters on the leaf undersurface. Young larvae often aggregate when first feeding on leaves then enter the stem at the point of leaf attachment. The number of generations per year varies from one, in northern Japan and Manchuria, to seven in southwest China and Africa. Mature larvae overwinter in stalks.

Potential U.S. Distribution: Throughout the U.S. wherever host plants occur.

Recommended Survey Areas: Major rice growing areas (see map). AR, LA, TX, CA, MS, MO.

Pheromone: 75.2:16.5:8.3 mixture of (Z)-11-Hexadecenal, (Z)-13-Octadecenal and (Z)-9-Hexadecenal.
loading rate - 109 ug + 109 ug BHT (andioxidant)
dispenser type - Rubber septa "extracted"
field life - 30 day - replace baits every 30 days.

Sources of Pheromone Dispensers: Raylo Chemicals Ltd., Health-Chem Corp., and Otis Methods Development Center

Traps: United Agri Products and Trece Wing Traps

Trap Placement: Within fields of host crops traps should be suspended from stakes just below the crop height and raised as the crop matures.

Recommended Combinations: None presently recommended.

Non-target species that may be captured: No reports of non-target Lepidoptera that are captured.

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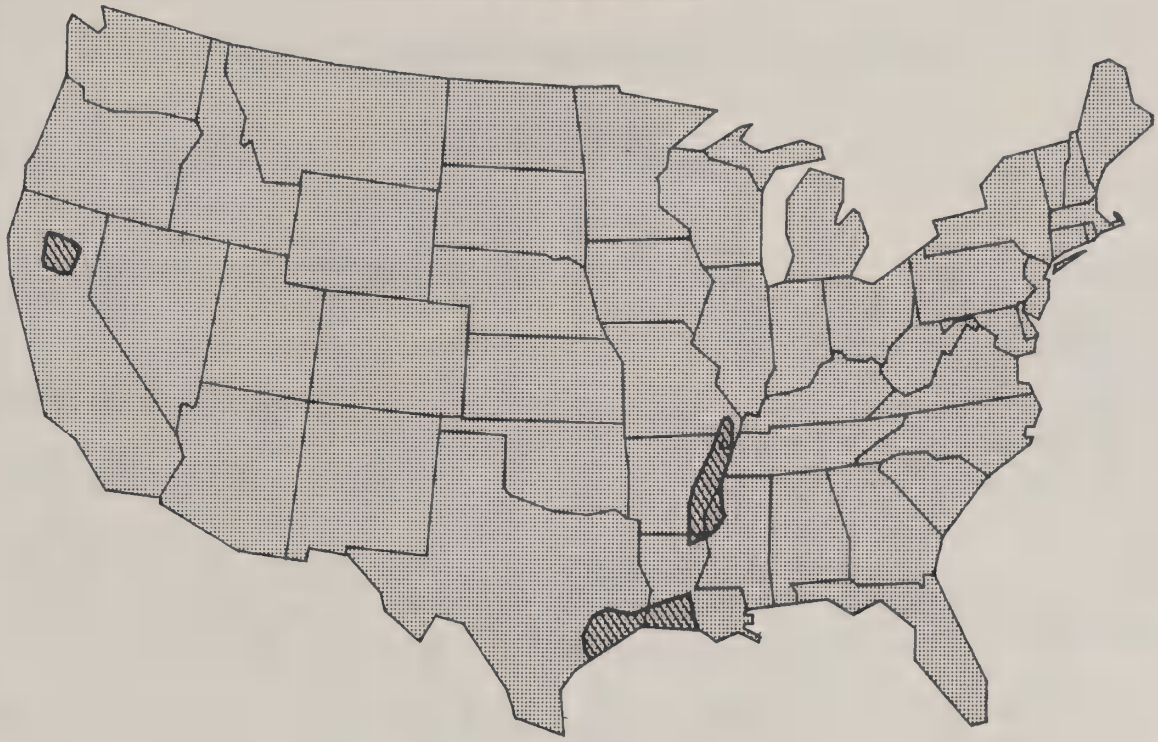
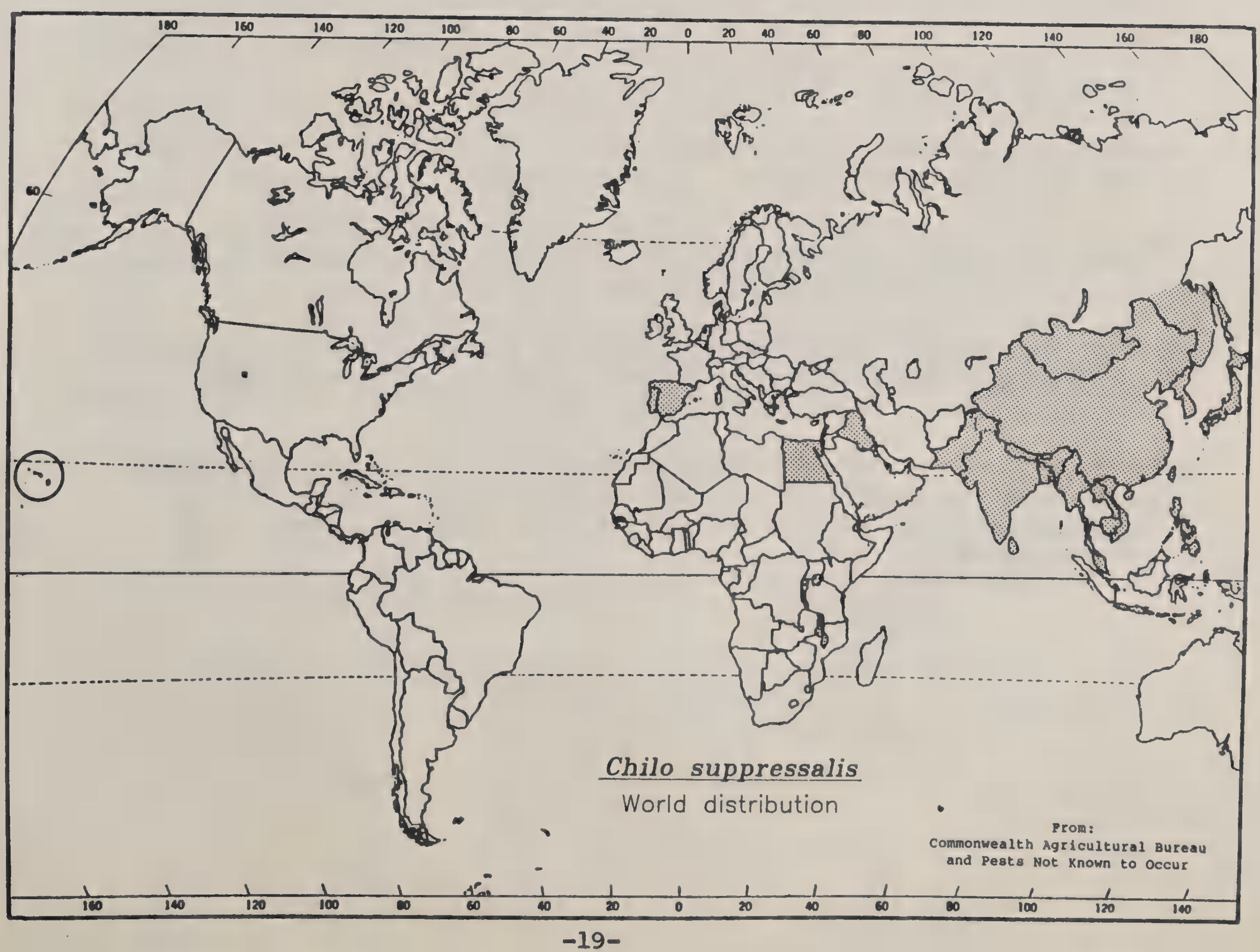
Chilo suppressalis



Major host growing areas
(see attached maps for additional detail)

Potential ecological range



Chilo suppressalis
World distribution

SELECTED REFERENCES
for
Chilo suppressalis

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Cryptophlebia leucotreta   False codling moth

Hosts: Citrus, Cotton, Sorghum, Corn, Peach, Oak, etc.

Distribution: See map

Biology: This tortricid is multivoltine with up to six generations annually in S. Africa, where it breeds throughout the year on oranges. Depending on temperature, it can complete a generation in 45-100 days. There was no mention of a diapause in the literature reviewed. Females fly at night and usually deposit about 150-200 eggs, beginning 2-3 days after emergence. Eggs are laid on the leaves and bolls of cotton and on the fruit of citrus, and hatch in 4-14 days. Eight days of temperatures below 1.1°C is lethal to the eggs, however high mortality will also occur at 13°C and 30 percent relative humidity. The developmental threshold for eggs is 11.9°C. Larvae feed in the fruit and bolls and then drop to the soil surface to pupate. Twenty-one days of temperatures below -0.6° is lethal to larvae, and prepupal and pupal mortality is high at average ambient temperatures of 10.5°C and below.

Although this species has a wide host range, apparently it is of greatest economic importance on citrus and cotton, which have suffered major losses in Africa.

Potential U.S. Distribution: In areas where the average annual minimal temperature is not below -10°C (see map).

Recommended survey area: Major citrus and cotton growing areas (see map). TX, CA, MS, AZ, AR, LA, OK, AL, TN, MO, NM, SC, GA, NC, FL

Pheromone: 50:50 mixture of (Z):(E)-8-Dodecen-1-ol acetate
dispenser type - strips of hollow fibers
field life - 8 weeks, replace bait midseason or every 8 weeks, which ever time period is shorter

Commercial source of pheromone dispensers: United Agri Products; Trece Corp.

Traps: United Agri Products, Trece Corp. (Wing Trap)

Trap placement: In citrus and peach orchards traps should be suspended from the tree limbs at ca. 1.5 meters in height. In row crops, traps should be placed on stakes at the same height as the crop.

Recommended combinations: None presently recommended. (The exotic *Pectinophora scutigera* is compatible with *C. leucotreta*.)

Non-target species that may be captured: Another exotic, *Cryptophlebia* sp. (*C. peltastica*) is attracted to this bait. A noctuid, *Hyperstrotia* sp. is also attracted as is the cypress twig moth, *Cydia cupressana*.

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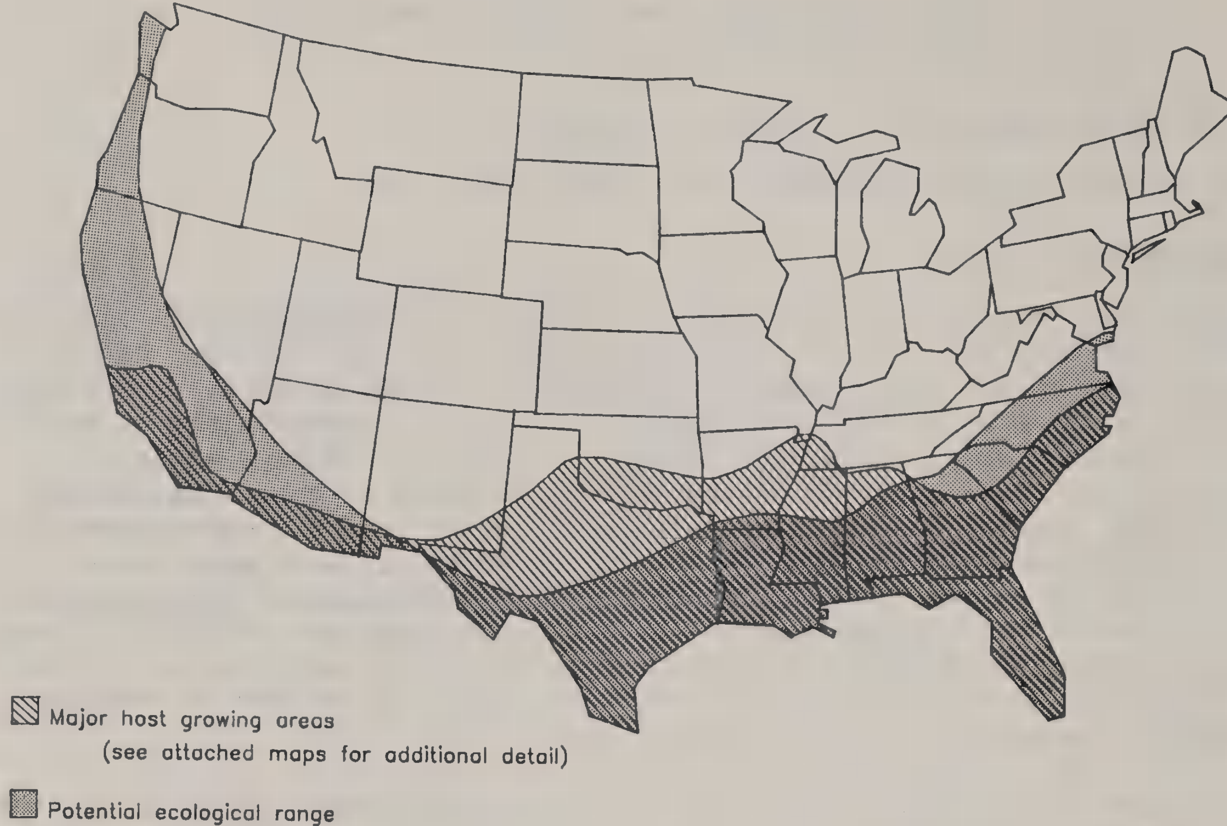
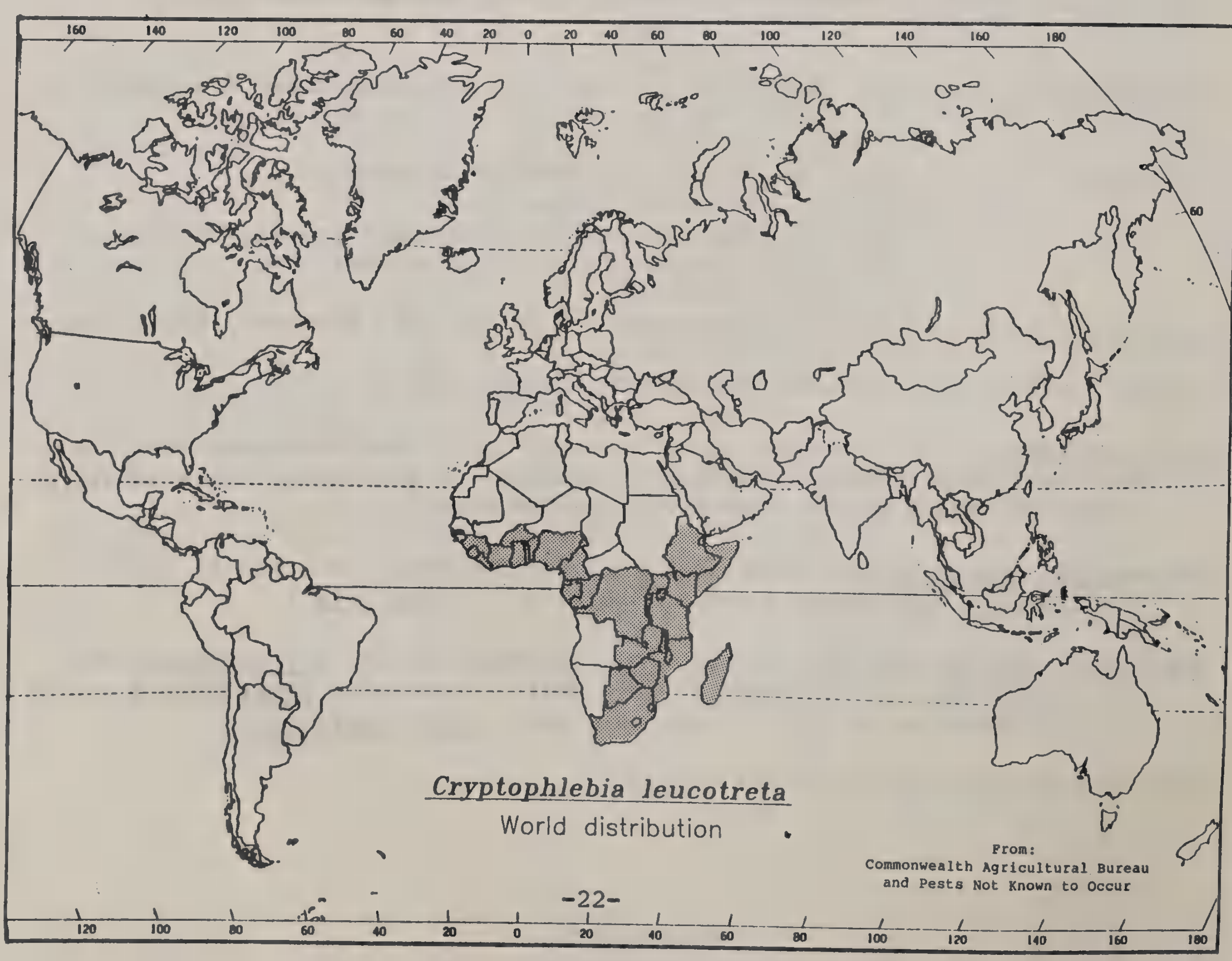
Cryptophlebia leucotreta





Cryptophlebia leucotreta
World distribution

SELECTED REFERENCES
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Cydia funebrana (=Grapholitha)   Plum fruit moth

Hosts: Plum, Cherry, Apple, Peach, Apricot, Pear, Walnut

Distribution: See map

Biology: This tortricid overwinters as prepupae in cocoons under bark flaps. It has a facultative diapause induced in 2nd and 3rd instar larvae by day lengths less than 14 hours, and completes two generations in temperate areas, but three in S.W. Hungary and Iran. Adults emerge in the spring at 30 accumulated degree-days C (ddC), based on a 10°C developmental threshold, with a generation time of 420 ddC. The second generation flight period begins between 450-500 ddC (June-July). Females lay 49-150 eggs singly on leaves or fruit. Larval feeding in fruit causes a characteristic emission of gum, and first generation larvae may cause premature fruit drop. Second generation larvae cause the greatest damage in later fruiting varieties.

Potential U.S. distribution: Throughout the US wherever host plants occur.

Recommended survey areas: Major plum, cherry, apple and peach producing areas (see map). WA, NY, MI, CA, PA, VA, NC, WV, OR, NJ, IL, MA, ME, ID, CO, MD, OH, MO, NH, WI, IN, UT, VT, CT, IA, MN, SC, GA.

Pheromone: 95:5 mixture of (Z):(E)-8-Dodecen-1-ol acetate
dispenser type - rubber septa
field life - 4 weeks, replace baits midseason or every 4 weeks which ever time period is shorter

Commercial sources of pheromone dispensers: United Agri Products

Traps: United Agri Products, Trece (Wing Trap)

Trap placement: within orchards of host trees, suspended from limbs ca. 1.5m high.

Recommended combinations: Plum fruit moth baits can be combined with no more than one of the following baits: gypsy moth, Lymantria dispar, or codling moth, Laspeyresia (Cydia) pomonella.

Combination #1 - Traps baited for C. funebrana and L. dispar should be located in orchards which are hosts of C. funebrana but near potential hosts for L. dispar.

Pheromone dispensers for L. dispar should be USDA dispensers (Hercon).

Combination #2 - Traps baited for C. funebrana and L. pomonella should be placed in orchards which both species use as a host or in mixed orchard situations where favored hosts of both species are available. In

the latter case, the trap should be placed in the orchard which is the favored host (i.e. plum) of *C. funebrana*.

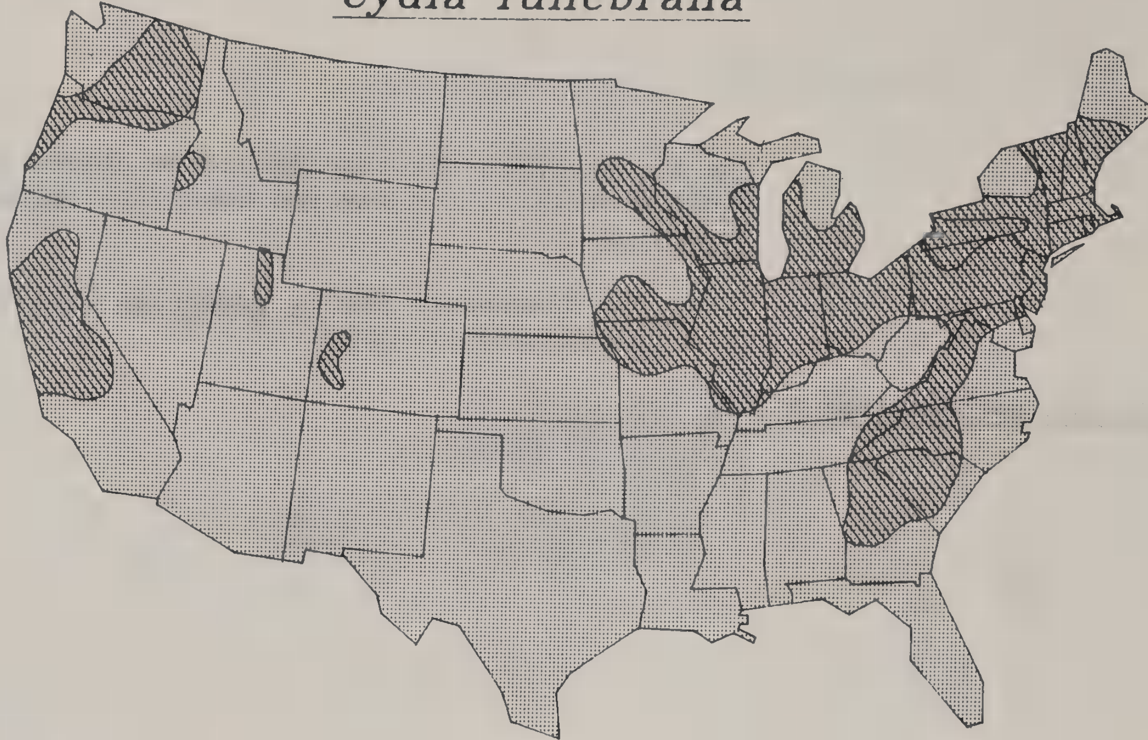
Pheromone dispensers for *L. pomonella* available from United Agri Products.

Non-target species that may be captured:

Grapholitha prunivora
G. molesta
Phyllonorycter blancardella
(Lepidoptera:Gracillariidae)

Otis Methods Development Center 9/4/86

Cydia funebrana



Major host growing areas
(see attached maps for additional detail)

Potential ecological range

Cydia funebrana
World distribution

From:
Commonwealth Agricultural Bureau
and Pests Not Known to Occur

SELECTED REFERENCES
for
Cydia (=Grapholitha) funebrana

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EXOTIC PEST DETECTION SURVEY RECOMMENDATIONS

Epiphyas postvittana   Light brown apple moth

Hosts: This species has a wide host range, and has been reported to feed on at least 73 plant species from 27 families. Economic damage, however, occurs most commonly on apples.

Distribution: See map.

Biology: In southern Australia and New Zealand this tortricid has three generations per year and overwinters as a larva. All stages have a lower threshold for development of 7.5°C and, with no mention of diapause in the literature, this species would most likely be limited to the southern U.S.

Female moths deposit egg masses on the upper leaf surface or on fruit. After dispersing, newly hatched larvae construct silken shelters on the underside of leaves, usually near a midrib or large vein. Older larvae roll together leaves and buds or fruit with webbing. Larvae feed and then pupate within these "nests".

Potential U.S. Distribution: Where the average minimal temperatures are above -10°C (see map).

Recommended Survey Areas: Major apple producing states within ecological range (see map) CA, OR, NC, VA, SC, GA.

Pheromone: 25:1 mixture of (E)-11-Tetradecen-1-ol acetate: (E,E)-9, 11-Tetradecadien-1-ol acetate.
Loading rate - 1.0 mg
Dispenser type - Rubber Septa
Field Life - 30 days - replace baits every 30 days.

Source of Pheromone Dispensers: Otis Methods Development Center.

Traps: United Agri Products and Trece Wing Traps

Trap Placement: Within orchards of host (apple, pear). Suspend traps from the limbs of trees ca 1.5m in height.

Recommended Combinations: None presently recommended.

Non-target species that may be captured:
Gracillariidae:
Phyllonorycter spp.
Pyralidae:
Pyrausta rubricalis
Tortricidae:
Archips rosaceana

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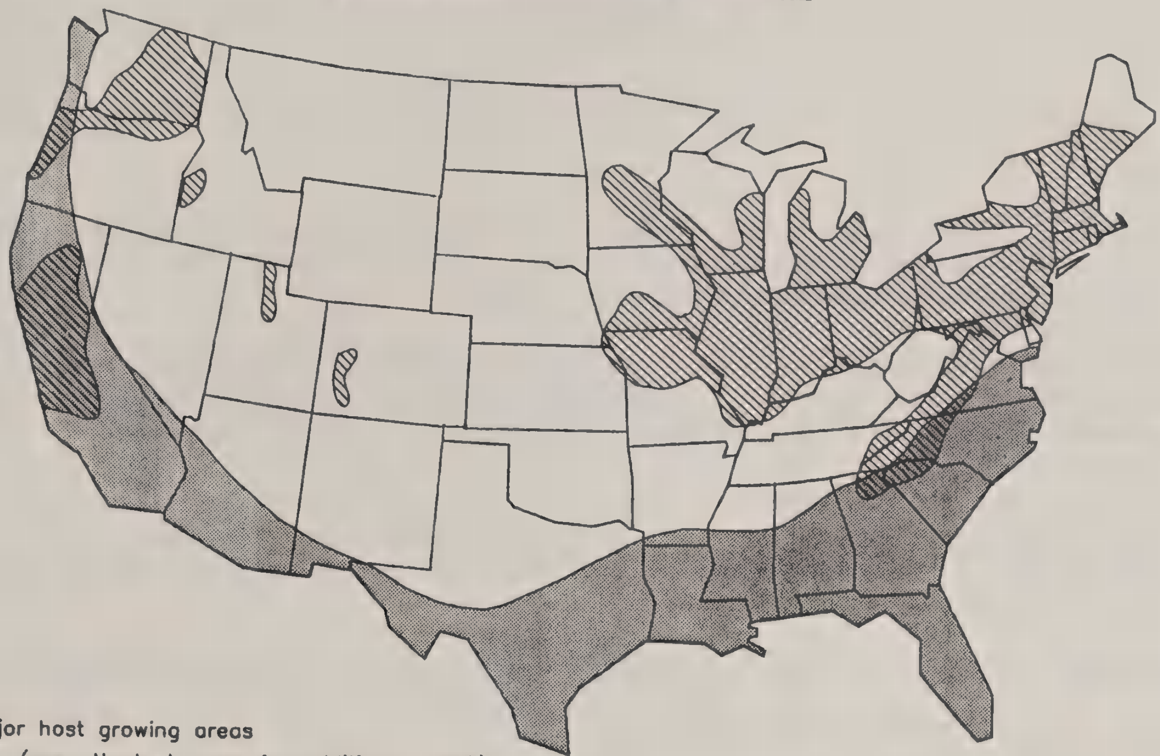
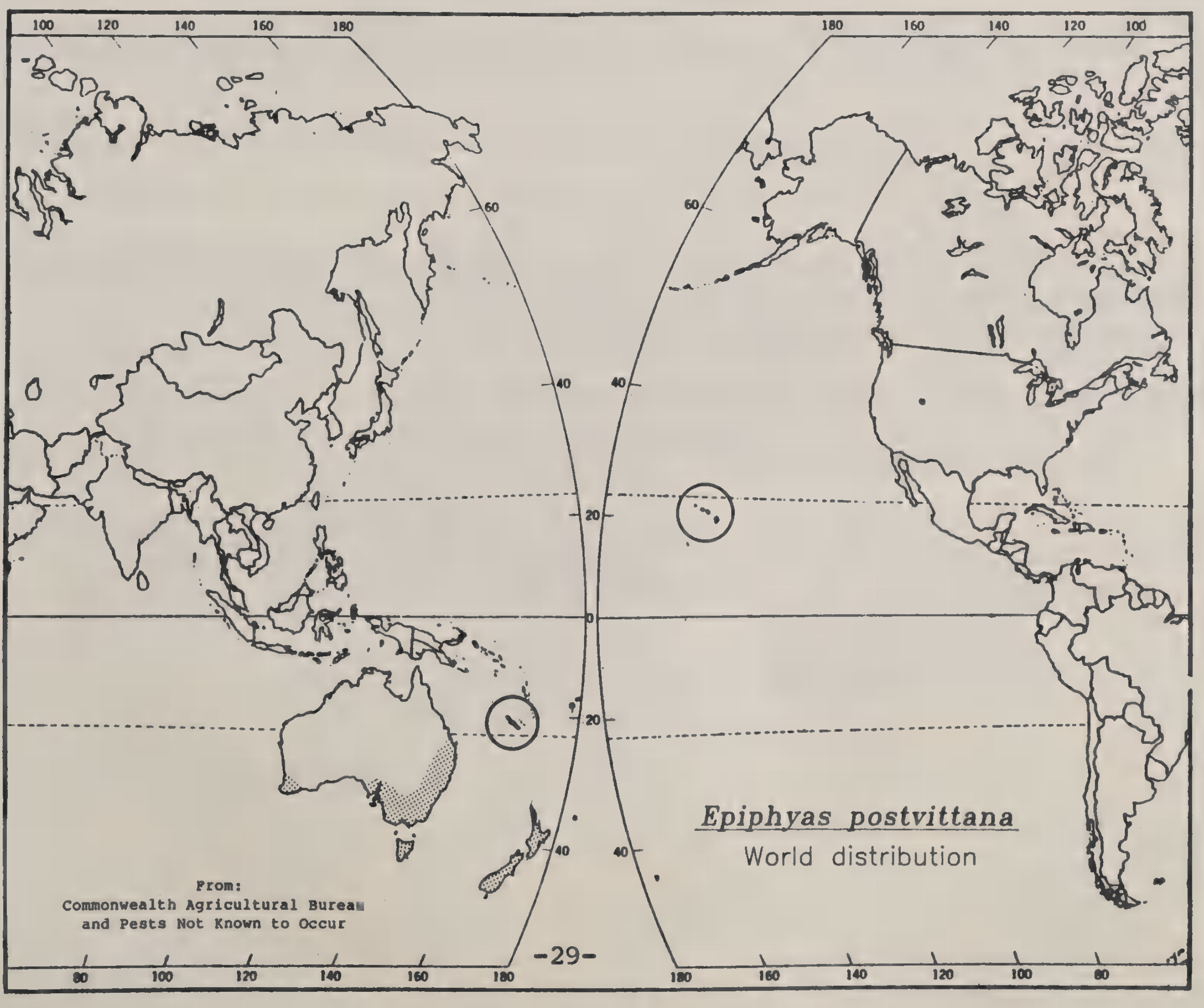
Epiphyas postvittana



Major host growing areas
(see attached maps for additional detail)

Potential ecological range



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for
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Eupoecilia (=*Clysia*) *ambiguella* European grape berry moth

Hosts: Grapes

Distribution: See map

Biology: There are two generations per year throughout Europe. The pupa is the overwintering stage. In Bulgaria, adults emerge in May and second generation adults occur around the first of July. First generation eggs are laid on flower buds, whereas second generation eggs are laid on grapes. Larvae feed on the flowers or grapes and usually pupate under bark flaps.

Potential U.S. Distribution: Throughout the country wherever host plants occur.

Recommended Survey Area: Major grape producing states (see map). CA, NY, WA, MI, PA, OH, AZ, AR, NC, MO.

Pheromone: 1:1:2 mixture of (Z)-9-Dodecen-1-ol acetate:Dodecen-1-ol acetate:Octadecyl acetate
loading rate - 2 mg
dispenser type - rubber septa or plastic laminate
field life - 42 days - replace baits every 42 days.

Source of Pheromone Dispensers: Otis Methods Development Center; Hercon Corp.; Trece, United Agri Products

Traps: Trece and United Agri Products Wing Trap

Trap Placement: Within grape vineyards: ca 0.5-1.0m in height.

Recommended Combinations: *Eupocilia ambiguella* baits (the [5:1] 12:A:Z9-12:Ac) could be combined with those for *Lobesia botrana* within a single trap. However, the new formulation for *E. ambiguella* contains an additional component which has not been tested for its effect on *L. botrana*.

Non-target species that may be captured:

Gelechiidae:	*Phthorimaea operculella*	
Geometridae:	*Eusarca confusara*	
Noctuidae:	*Autographa precationis*	*Faronta diffusa*
Oecophoridae:	*Agonopterix pulvitennella*	
Tortricidae:	*Episemus argutanus*	*Endopiza viteana*
	Argyrotaenia velutinana	*Phaneta crispana*
	Pseudogalleria inimicella	*Ptycholoma teritana*
	Grapholitha prunivora	

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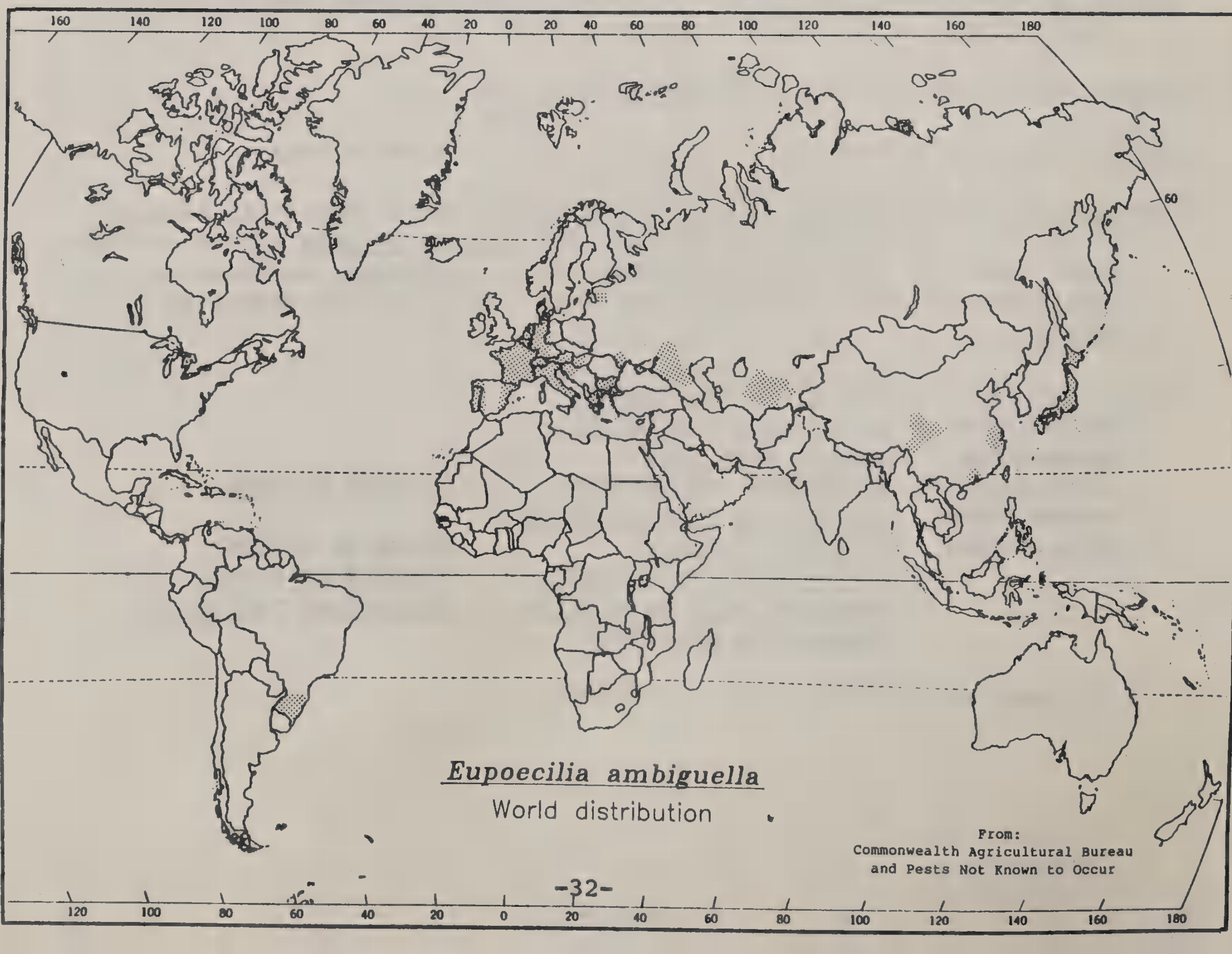
Eupoecilia ambiguella

Major host growing areas
(see attached maps for additional detail)

Potential ecological range



Eupoecilia ambiguella
World distribution

From:
Commonwealth Agricultural Bureau
and Pests Not Known to Occur

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for
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EXOTIC PEST DETECTION SURVEY RECOMMENDATIONS

Lobesia botrana Grape vine moth

Hosts: Grapes (Vitis) major host, also olives, privet, lilac, black currants and persimmons.

Distribution: See map

Biology: Lobesia botrana is a multivoltine species with four generations per year, depending on latitude. Diapause is facultative, occurring in the pupal stage whenever the eggs or early larval stages are exposed to day-lengths of less than 12 hrs. Over-wintering pupae live within cocoons located under fallen leaves or in cracks in the soil or under the grape vine bark.

Spring adult emergence will begin whenever the daily average air temperature is above the minimal threshold temperature of 10°C for 10-12 days. Traps for monitoring spring adult flight should be set up after 60 degree-days C (ddC). Adults will fly at dusk whenever the temperature is above 12°C, but rainfall or wind will reduce flight.

First generation eggs are laid on flower buds or pedicels of vines. The larvae feed on bud clusters before pupating inside them or under rolled leaves. It takes an average of 402 ddC to complete the first generation from sexual maturation of the parents to pupation.

The second generation eggs are laid singly on individual grapes. The larva will enter the grape and feed before pupating inside the grape. To complete the second generation, 441 ddC are required.

The third generation larvae also feed on the grapes but, unlike the second generation, will feed on more than one grape. The third generation normally produces diapausing pupae but may also give rise to a partial fourth generation.

Potential U.S. distribution: Throughout the U.S., wherever host plants occur (see map).

Recommended survey area: Major grape producing States (see map). CA, NY, WA, MI, PA, OH, AZ, AR, NC, MO

Pheromone: (E,Z)-7,9-Dodecen-1-ol acetate
dispenser type - rubber septa
field life - 3 weeks, replace baits every 3 weeks.

Commercial source of pheromone dispensers: Trece Corp., United Agri Products

Traps: Trece, United Agri Products (Wing Trap).

Trap placement: Lobesia botrana males are weak dispersers; therefore traps should be placed within grape vineyards. Traps should be suspended from wires or vines ca. 1/2 to 1 m above the ground. Care should be exercised in trap placement so that grape foliage does not block trap entry ports.

Recommended combinations: Compatible pheromones include attractants for the gypsy moth, Lymantria dispar, the codling moth, Laspeyresia (Cydia) pomonella and the European grape berry moth, Eupoecilia (Clysia) ambiguella. Only one of these attractants should be combined at a time in traps baited for Lobesia botrana.

Combination #1 — Traps baited for L. botrana and L. dispar should be placed in vineyards located close (within 300 m) to hosts for the gypsy moth.

Pheromone dispensers for L. dispar should be USDA dispensers (Hercon).

Combination #2 — Traps baited for L. botrana and L. pomonella should be placed in vineyards located adjacent to host (apple, pear, etc.) for the codling moth. In considering this combination, the effect of monitoring codling moth population with traps placed outside of the host crop will have to be weighed against the objective of the monitoring program (i.e. timing spray application, etc.).

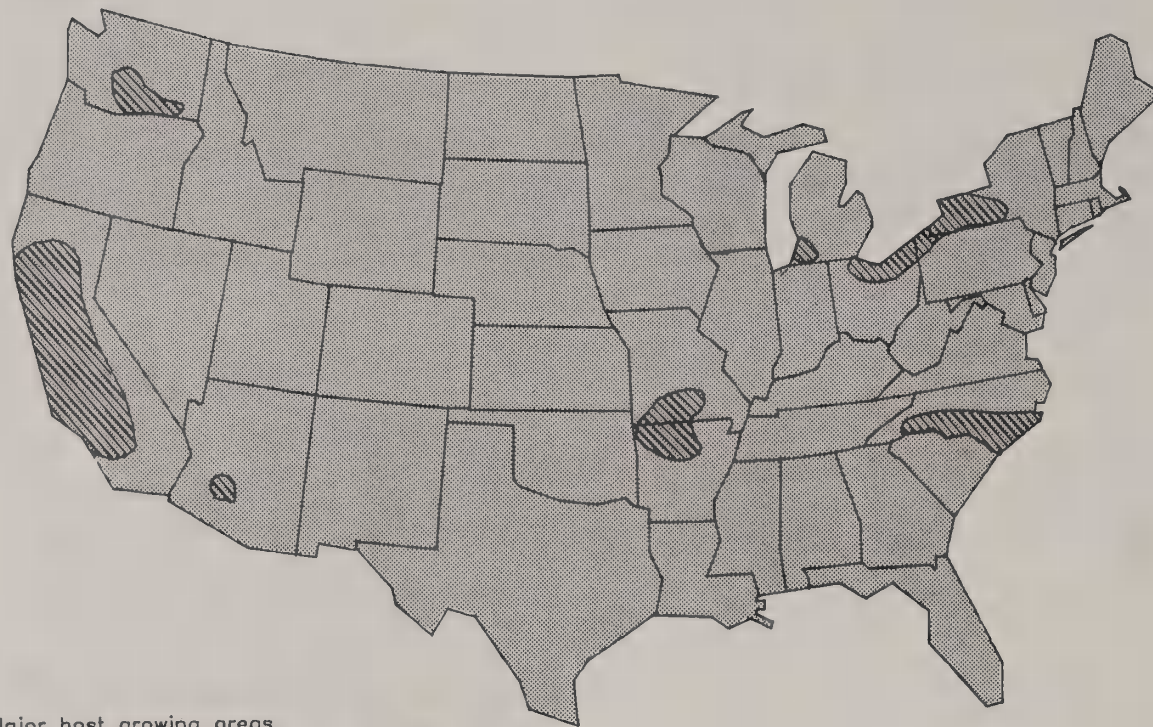
Pheromone dispensers for L. pomonella available from United Agri Products.

Combination #3 — The formulation for E. ambiguella baits has recently been changed by the addition of a third component. This new formulation has not been tested for its effect on L. botrana captures. Therefore, when baits for E. ambiguella are formulated using three components, this combination should not be used.

Non-target species that may be captured: No reports of major trap-loading by domestic non-target species have been noted.

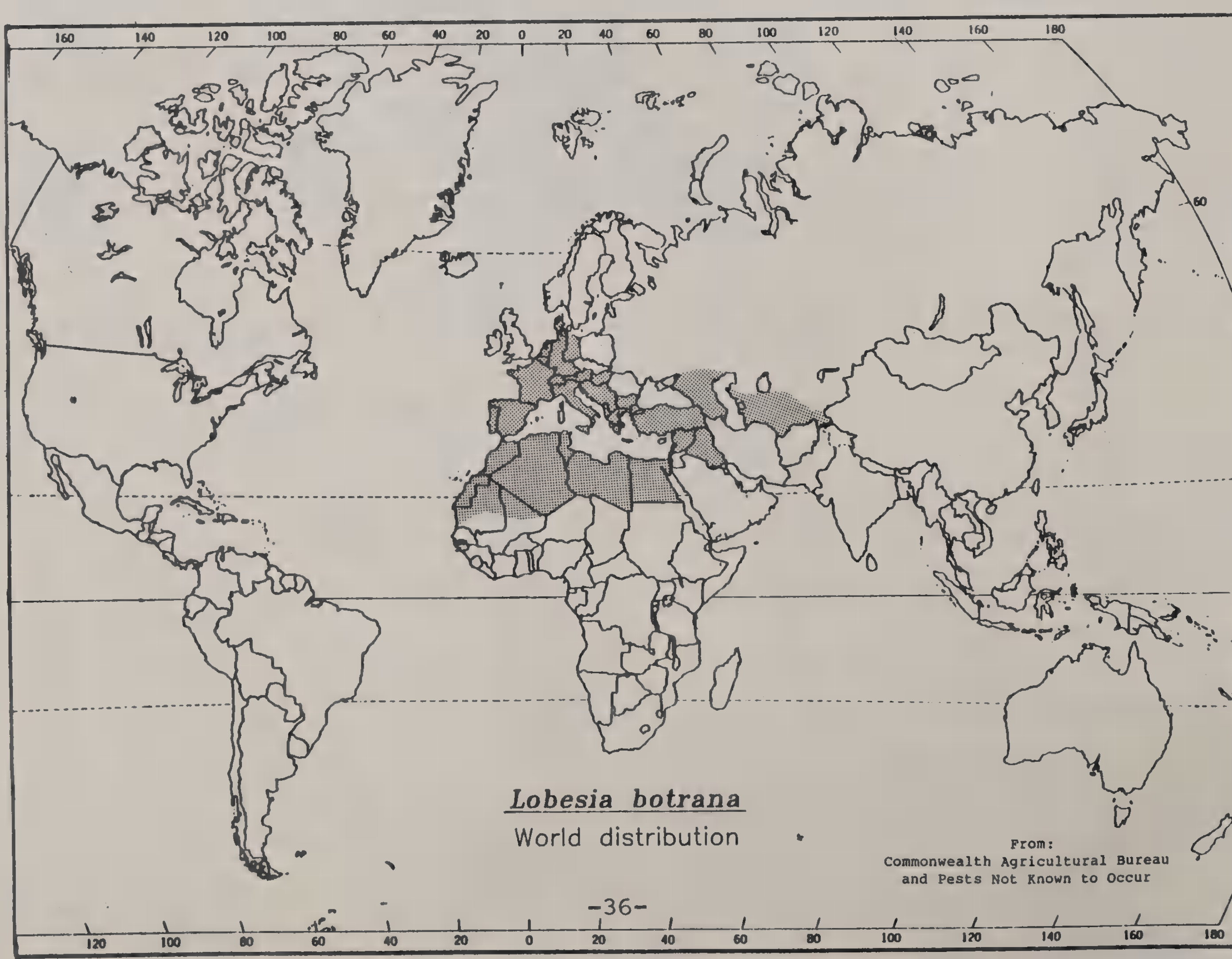
Otis Methods Development Center 9/4/86

Lobesia botrana



Major host growing areas
(see attached maps for additional detail)

Potential ecological range



Lobesia botrana
World distribution

From:
Commonwealth Agricultural Bureau
and Pests Not Known to Occur

SELECTED REFERENCES
for
Lobesia botrana

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Mamestra brassicae Cabbage moth

Hosts: Larvae of the cabbage moth are general feeders on many vegetables and field crops but damage is most often reported on crucifers.

Distribution: See map

Biology: Eggs are deposited in masses on the underside of leaves. Larvae feed on the leaves and in some instances, i.e. cabbage, bore into the head or stalk. Pupation occurs in the soil. There can be from one to two generations per year depending on climate. Overwintering occurs in the pupal stage.

Potential U.S. Distribution: Throughout the U.S.

Recommended Survey Areas: Major crucifer producing states (see map). CA, TX, NY, OR, AZ, MI.

Pheromone: (Z)-11-Hexadecen-1-ol acetate
loading rate - 1 mg.
dispenser type - poly caps or rubber septa
field life - 90 days

Source of Pheromone Dispensers: Otis Methods Development Center

Traps: Trece and United Agri Products Wing Trap

Trap Placement: Within fields of host crops; trap should be placed on stakes at approximately the crop height and raised as the crop matures.

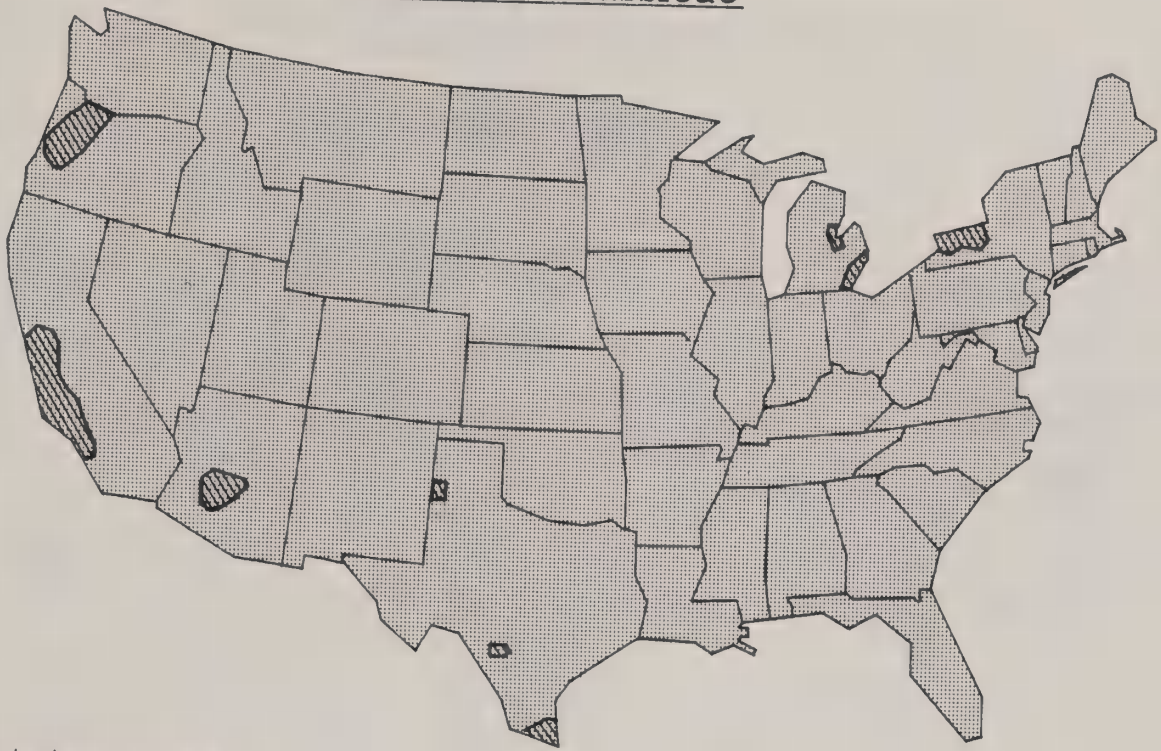
Recommended Combinations: None presently recommended.

Non-target species that may be captured:

Pieridae:	Pieris rapae	
Noctuidae:	Abrostola urentis	Aletia oxygala
	Autographa californica	Faronta diffusa
	Laconobia lutra	Orthodes crenulata
	Polia detracta	Polias spp
	Pseudaletia unipuncta	Scotogramma trifolii

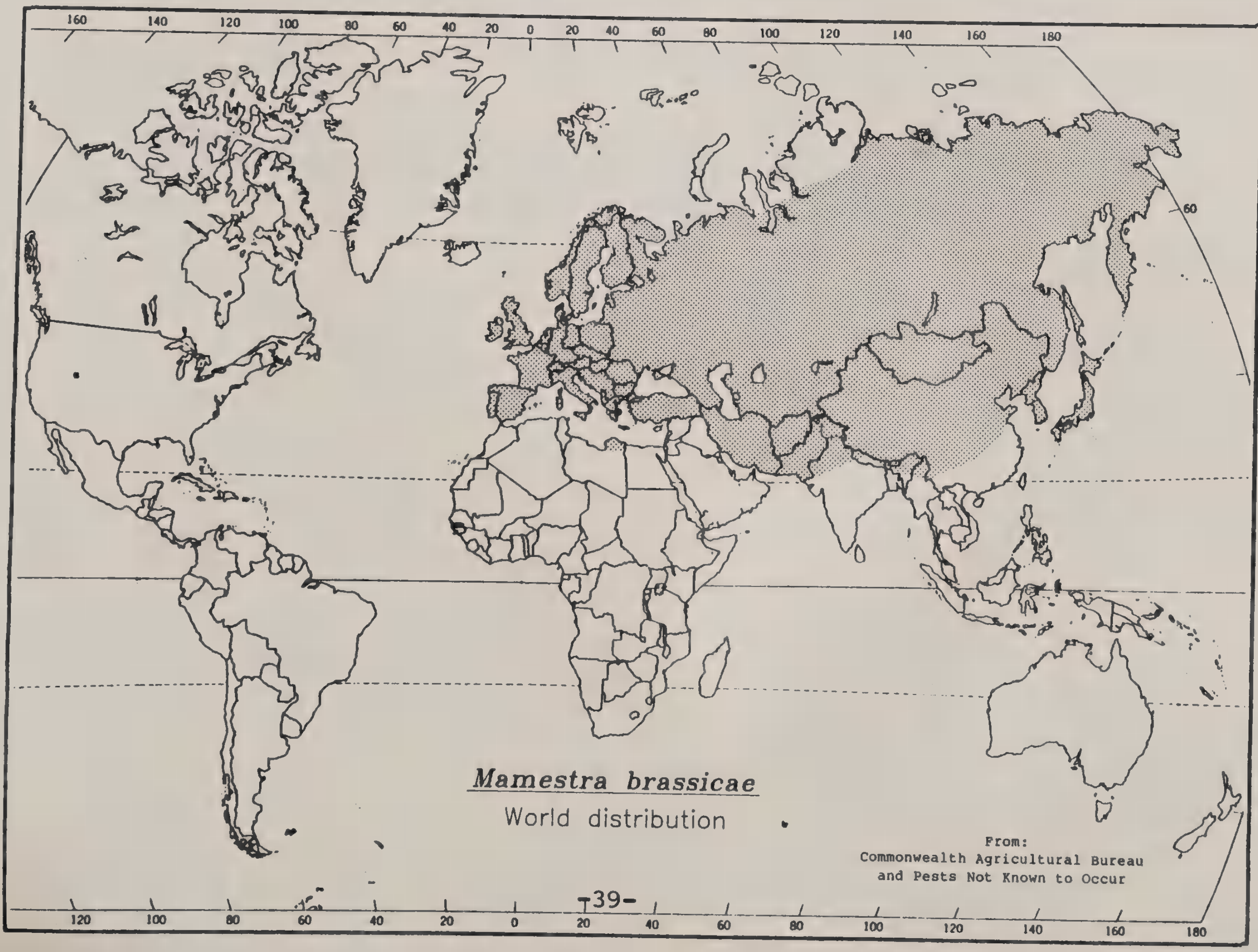
Otis Methods Devevlopment Center - 9/4/86

Mamestra brassicae



Major host growing areas
(see attached maps for additional detail)

Potential ecological range



Mamestra brassicae
World distribution

From:
Commonwealth Agricultural Bureau
and Pests Not Known to Occur

SELECTED REFERENCES
for
Mamestra brassicae

Anonymous. 1958. Cabbage moth (Mamestra brassicae [L.]). In: "Insects Not Known to Occur in the United States". Vol 8. pp. 45-46. Cooperative Economic Insect Report. USDA.

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Rhagoletis cerasi European cherry fruit fly

Hosts: Cherry, *Lonicera*

Distribution: See map

Biology: This fruit fly has one generation per year and overwinters as a puparium in the soil. In Switzerland, adult emergence occurs in the spring, after 430 degree-days C have accumulated at a soil depth of 5 cm, based on a 5°C developmental threshold,. This usually occurs in May or June, with the flight period lasting from one to two months. Puparia require cold soil temperatures (less than 0°C), for at least one month, for the majority to break diapause. Eggs are laid in the fruit where the larvae feed for 13-30 days. Damage can be as severe as in Italy, where up to 90 percent of the fruit has been infested.

Potential U.S. distribution: Throughout the U.S., wherever host plants occur (see map).

Recommended survey area: Major cherry producing States (see map). MI, WA, OR, CA, NY, PA, UT, WI, MT, CO, ID

Attractant: Ammonium acetate or Ammonium carbonate and visual attraction to the yellow Rebell trap.

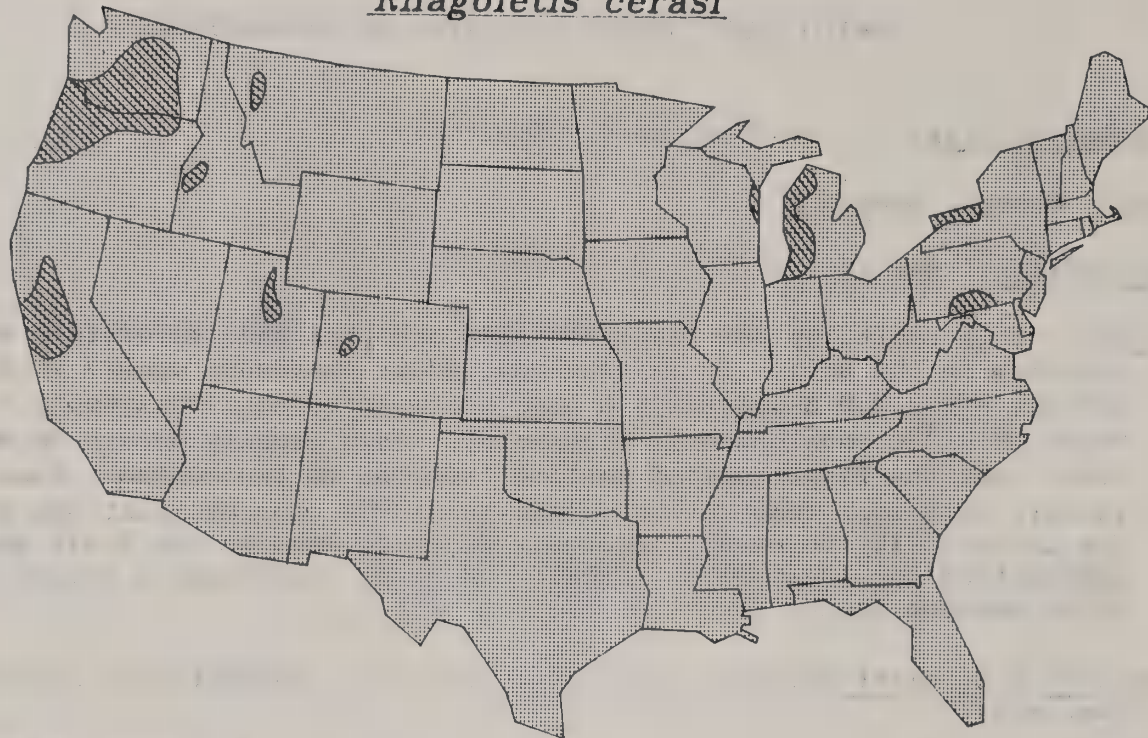
Commercial sources of attractant dispensers: Trece Corp.

Traps: Rebell trap from Great Lakes IPM Corporation or Swiss Federal Research Station

Recommended combinations: Because the attractants (visual and olfactory) employed by this trap are used by a variety of fruit pests, monitoring of native species distribution and abundance is also possible.

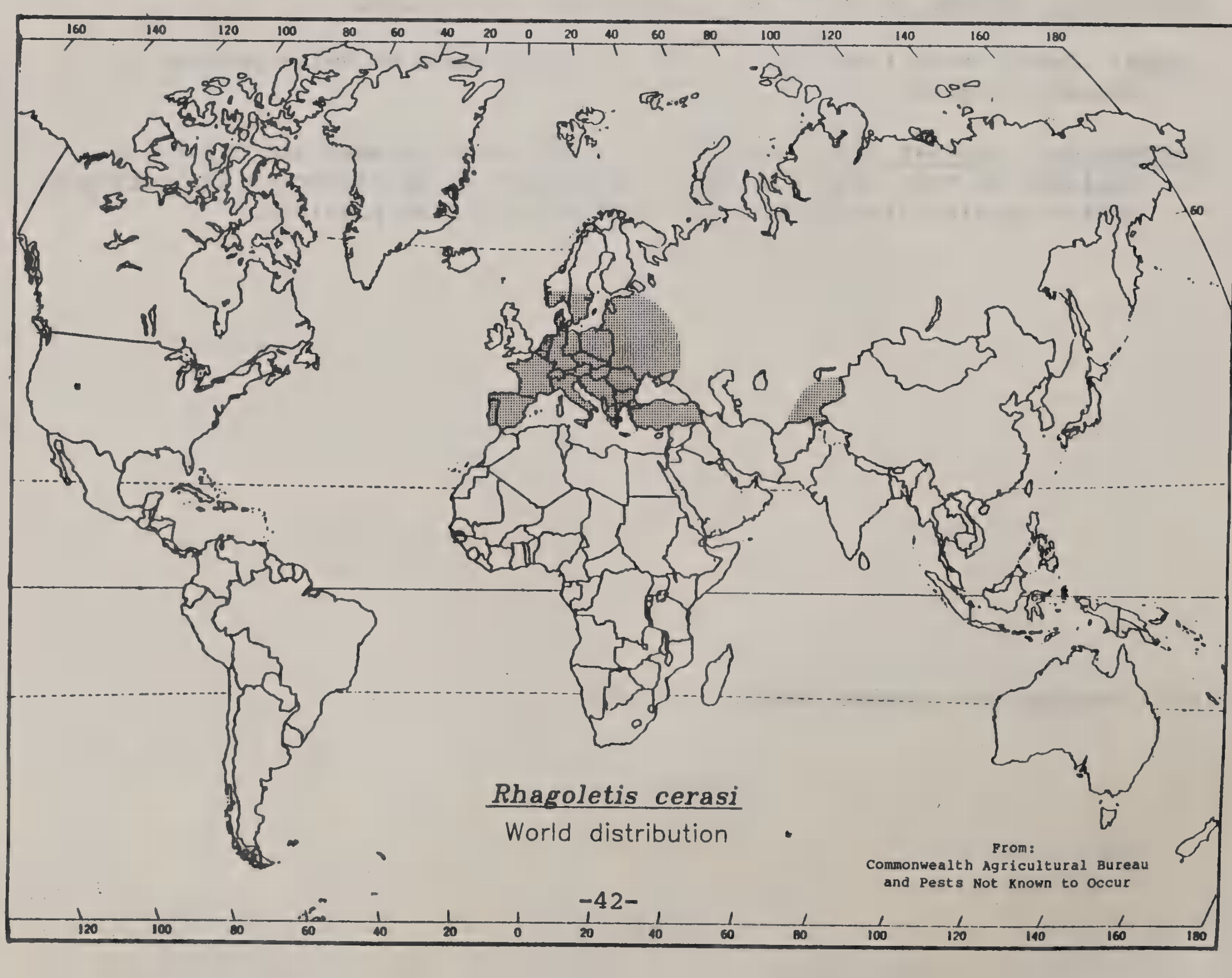
Otis Methods Development Center 9/4/86

Rhagoletis cerasi



Major host growing areas
(see attached maps for additional detail)

Potential ecological range



Rhagoletis cerasi
World distribution

From:
Commonwealth Agricultural Bureau
and Pests Not Known to Occur

SELECTED REFERENCES
for
Rhagoletis cerasi L.

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Katsoyannos, B.I. 1976. Female attraction to males in *Rhagoletis cerasi*. Environ. Entomol. 5(3):474-475.

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Spodoptera littoralis   Egyptian cottonworm (Egyptian cotton leafworm)

Hosts: Cotton, tobacco, alfalfa, soybeans, clover, vegetables, etc.

Distribution: See map

Biology: Spodoptera littoralis is a multivoltine species that does not enter a diapause stage, nor can it tolerate long periods of temperatures at 13°C or lower. S. littoralis can over-winter in southern Spain, but not in northern Italy or France.

The eggs are laid on the leaves of host plants and begin to hatch after 28.6 degree-days C (ddC) at a base temperature of 14.8°C. The optimal temperature for hatch is 28-30°C. Exposing the eggs to 13°C for eighteen days will result in complete egg mortality.

Newly-emerged larvae will feed on the leaves of cotton, but not on the large veins. Later instar larvae disperse widely, become nocturnal in habit, and will at times attack the young buds and cotton bolls. The larvae weaken the cotton plants and leave the plants susceptible to damage by the bollworms.

The optimal temperature for larval development is 25°C, and at a base temperature of 13°C, 257.1 ddC are required to complete the larval stage. Exposing the larvae constantly to 13°C does not prevent the larvae from forming prepupae, but all the prepupae will die.

Larvae pupate in the soil, and at the 13°C base temperature, male and female pupae complete their development in 177.1 and 153.5 ddC, respectively. Exposing the pupae to 13°C for seventy days will result in few adults emerging, and those that do emerge will be deformed and incapable of mating. Exposing the pupae to temperatures above 30°C will also result in poor survival. The females which do emerge will deposit many non-viable eggs. The optimal temperature for pupal survival is 20°C.

The adults emerge at night, with the males emerging about three hours after the females. The males can mate 5-6 times, but usually mate only once a night. The females will mate, at the most, twice. Few males will fly at temperatures below 13°C. The distance the adults migrate is unknown, although marked moths have been captured as far as 1500 meters from a release site. An infestation in France is thought to have come from migration of adults from overwintering areas in southern Spain.

Potential U.S. distribution: In areas where the average annual minimal temperature is not below -10°C (see map).

Recommended survey area: Major cotton producing states (see map). TX, CA, MS, AZ, AR, LA, OK, AL, TN, MO, NM, SC, GA, NC, FL.

<u>Pheromone</u>: 99.5:0.5 mixture of (Z,E)-9,11:(Z,E)-9,12-tetradecadien-1-ol acetates
dispenser type - rubber septa or poly cap or plastic laminate
field life - 2 weeks, replace lure dispensers every 2 weeks.

<u>Commercial source of pheromone dispensers</u>: Hercon, Trece

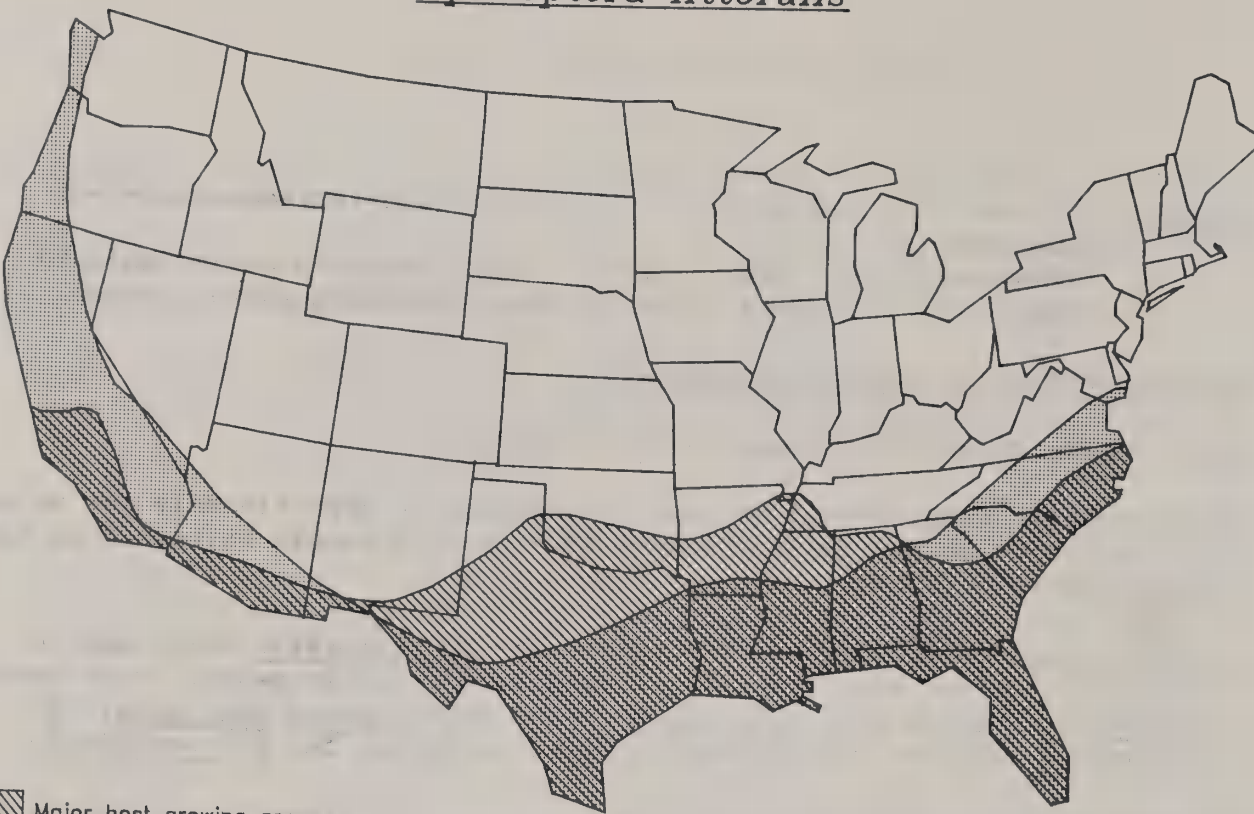
<u>Traps</u>: Trece, United Agri Products (Wing Trap)

<u>Trap placement</u>: Traps should be hung from stakes at approximately the height of the crop. As the season progresses, the trap should be raised as the crop height increases.

<u>Recommended combinations</u>: Egyptian cottonworm *S. littoralis* baits can be combined in traps with baits for the following exotic pests: rice cutworm *Spodoptera litura*, *Heliothis armigera* and *Pectinophora scutigera*. *S. littoralis* can also be included in domestic survey for *P. gossypiella*.

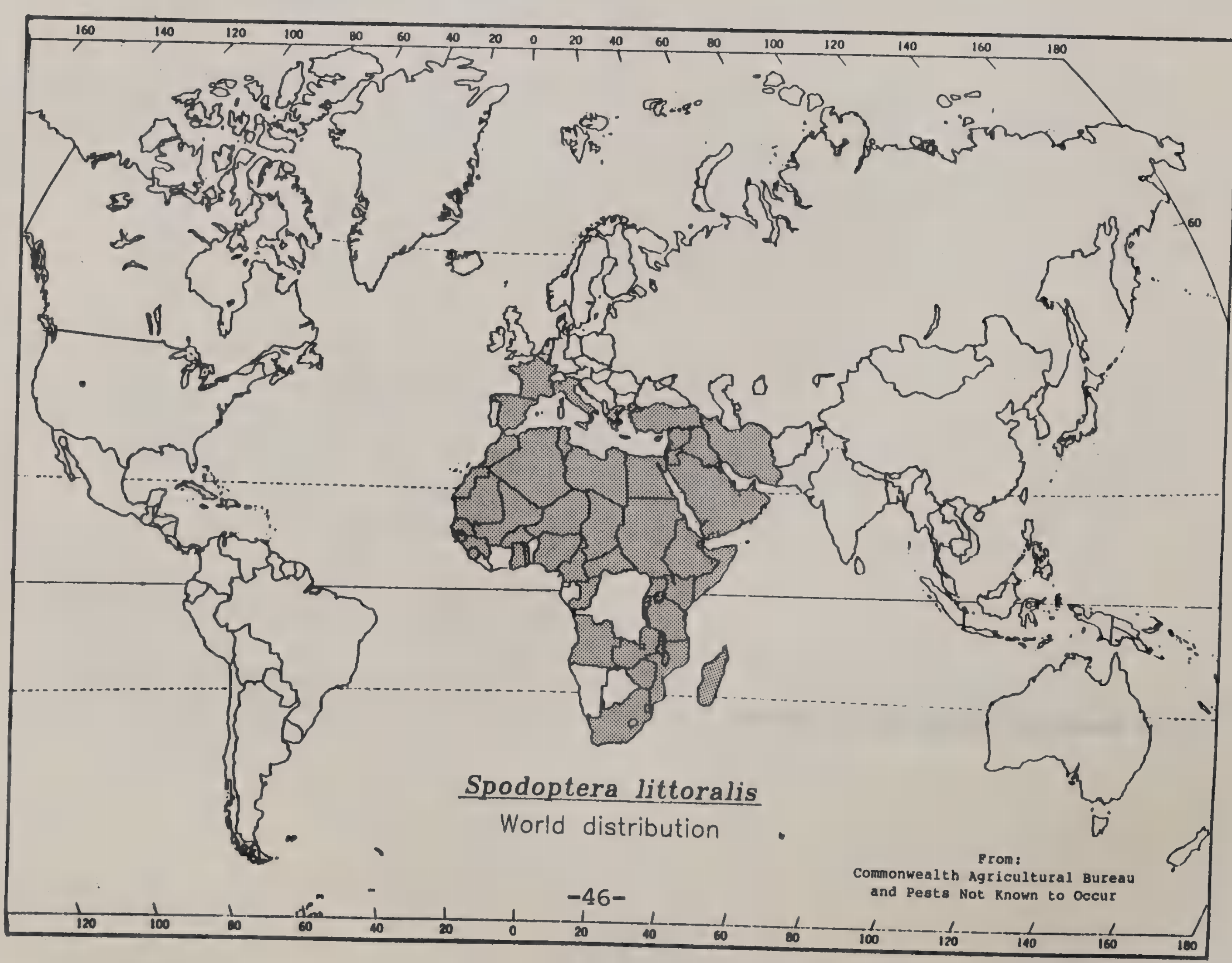
<u>Non-target species that may be captured</u>: The noctuid *Erastria* sp. has been reported in *S. littoralis* traps.

Spodoptera littoralis



Major host growing areas
(see attached maps for additional detail)

Potential ecological range



Spodoptera littoralis
World distribution

From:
Commonwealth Agricultural Bureau
and Pests Not Known to Occur

SELECTED REFERENCES
for
Spodoptera littoralis

Anonymous. 1982. Egyptian cottonworm, *Spodoptera littoralis* (Boisduval). In: "Pests Not Known to Occur in the United States or of Limited Distribution". No. 25. USDA, APHIS, PPQ.

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Spodoptera litura   Rice cutworm (cotton leafworm)

Hosts: Cotton, Tobacco, Grapes, Corn, Soybeans, Vegetables

Distribution: See map

Biology: Spodoptera litura is a multivoltine species with no known diapause stage. It has 2 generations/year in China, 4 to 5 generations/year in Japan and up to 8 generations/year in Taiwan. Temperatures of 10°C or lower will cause mortality in all the life stages with the most cold resistent stages capable of surviving -2°C for only 1 day.

A generation normally requires 526.3 degree-days C at a base temperature of 10.3°C. The eggs hatch in 4 days at 26.7°C. Newly hatched larvae are very susceptible to dry heat; consequently, they usually stay on the lower leaf surfaces during the day and feed at night. During the last two instars, the larvae feed only at night and find shelter during the day under the lowest leaves or in the soil at the base of the host plants. The larvae either defoliate the plant or cut it off like a cutworm.

At 28.6°C larvae pass through 6 instars in approximately 13 days and pupate within earthen cells. The pupal stage is completed in 7.3 and 6.1 days for male and female pupae, respectively, at 28.6°C.

The adults emerge at night between 11:00 p.m. and 3:00 a.m. The males can fly up to 5 km/night; however, flight is greatly reduced at temperatures below 20°C. The males will mate once each night and will avoid any females mated previously.

The females begin to deposit their eggs 2 to 3 days after emerging. The eggs are deposited at night in batches of up to 300 eggs on the under-surface of host leaves. A female can deposit from 6 to 9 batches of eggs over a 7 day life span.

Potential U.S. distribution: In areas where the average annual minimal temperature is not below -10°C (see map).

Recommended survey area: Major cotton producing States, and Florida (see map). TX, CA, MS, AZ, AR, LA, OK, AL, TN, MO, NM, SC, GA, NC, FL.

Pheromone: 88:12 mixture (Z,E)-9,11:(Z,E)-9,12 Tetradecadien-1-ol acetate
dispenser type - rubber septa or polycaps
field life - 2 weeks, replace lure dispensers every 2 weeks

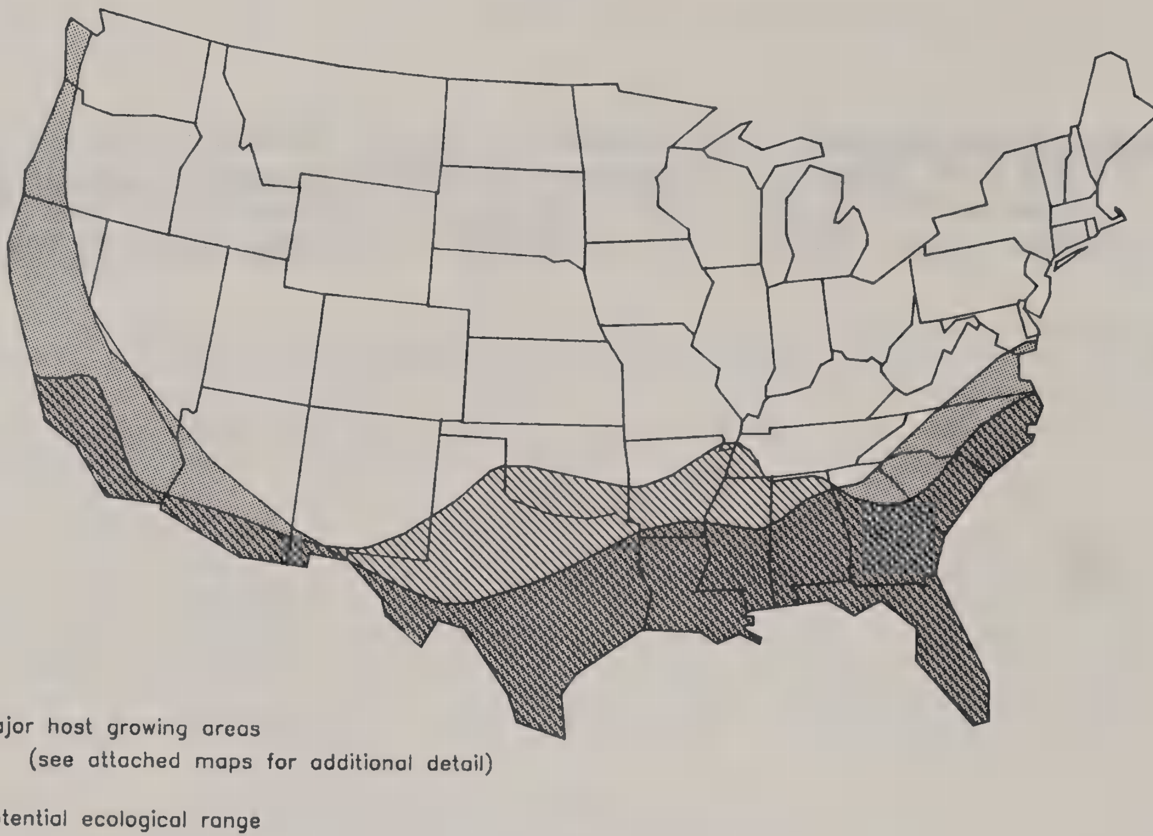
Commercial sources of pheromone dispensers: Trece and United Agri Products

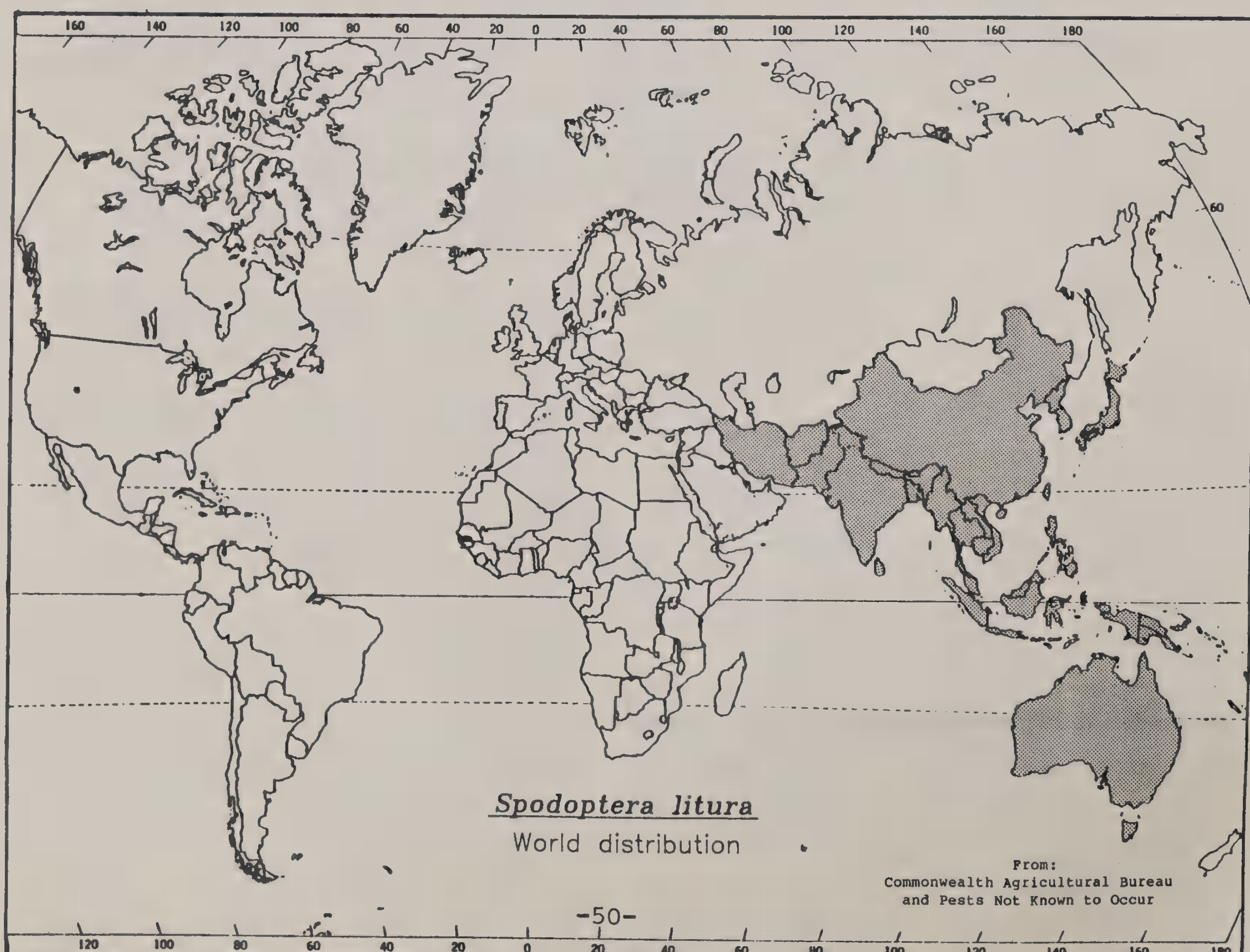
Traps: Trece, United Agri Products (Wing Trap)

Trap placement: Trap should be hung from stakes at approximately the height of the crop. As the season progresses, the trap should be raised as the crop height increases.

Recommended combinations: Rice cutworm (S. litura) baits can be combined in traps with baits for the Egyptian cottonworm Spodoptera littoralis. Traps baited for S. litura and S. littoralis can be placed in any of the following crops: cotton, tobacco, soybeans, alfalfa, clover or vegetables.

Spodoptera litura





SELECTED REFERENCES
for
Spodoptera litura

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ponomeuta malinellus synonymous

Apple ermine moth
Hyponomeuta malinellus
Yponomeuta padellus malinellus

Hosts: *Malus* spp.

Distribution: See map (the exact distribution is unknown)

Biology: *Yponomeuta malinellus* is a univoltine insect. Adult moths are nocturnal flyers and egg masses are deposited on twigs and small limbs of the host from mid-July through September. The larvae begin to hatch in the fall, but form a hibernaculum under the egg mass. Larvae emerging in the spring from hibernacula begin to mine leaves. Later instars feed on the surface of leaves which are pulled together in bunches. Pupation occurs in the webbed-up leaves.

Present U. S. Distribution: Western Washington, presumably introduced from British Columbia where it was detected in 1981.

Potential U. S. Distribution: All apple growing areas.

Recommended Survey Areas: Apple producing states, states recently receiving nursery stock from British Columbia, Canada or Washington.

Pheromone: A 200:3 mixture of (Z)-11-Tetradecen-1-ol and (Z)-9-Dodecen-1-ol acetate
- loading rate - 203 ug
- dispenser type - rubber septa
- field life - 6 weeks

Source of Pheromone Dispensers: Otis Methods Development Center

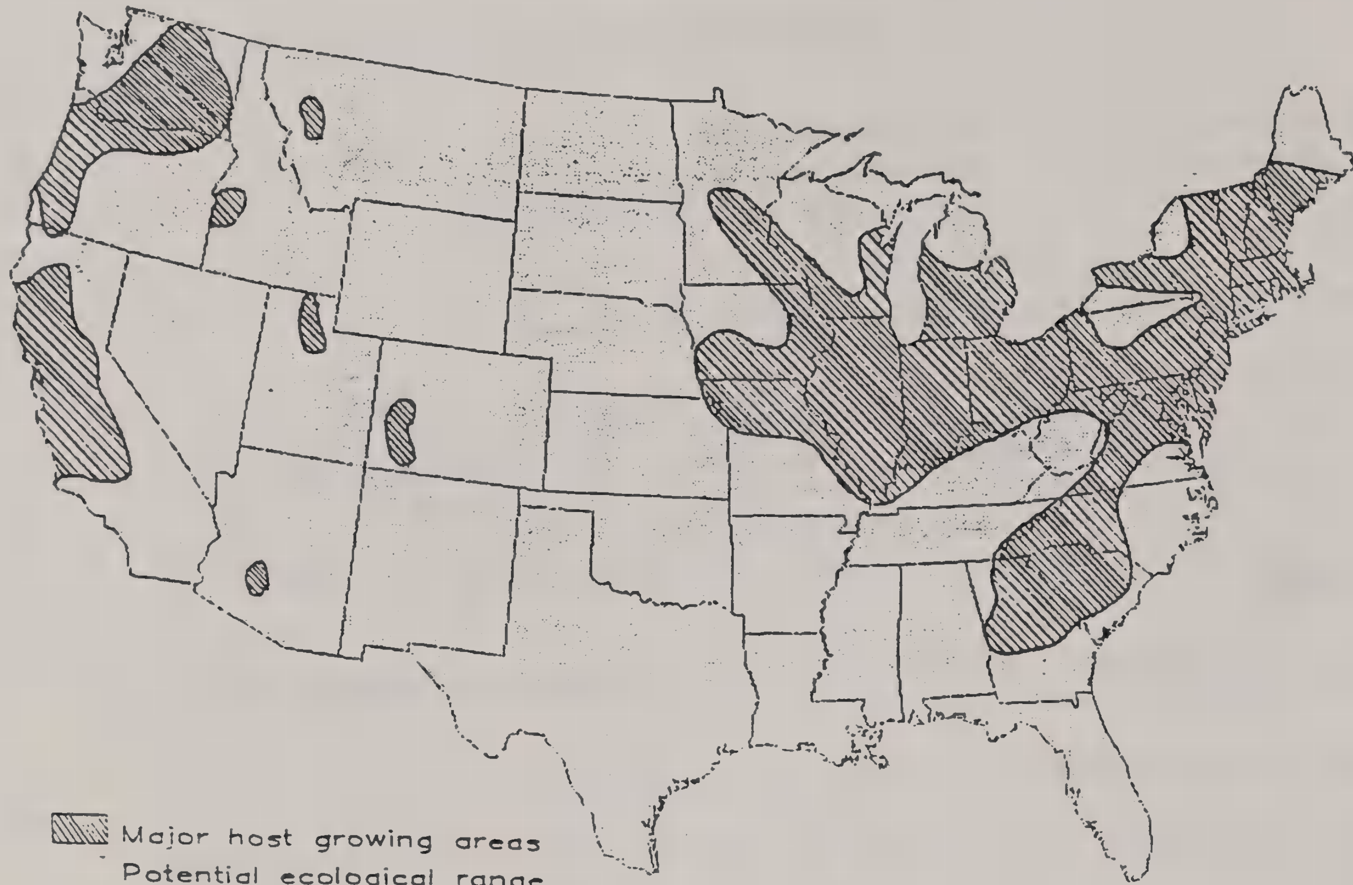
Traps: Wing type United Agri Products and Trece Wing Trap "Plastic Top"

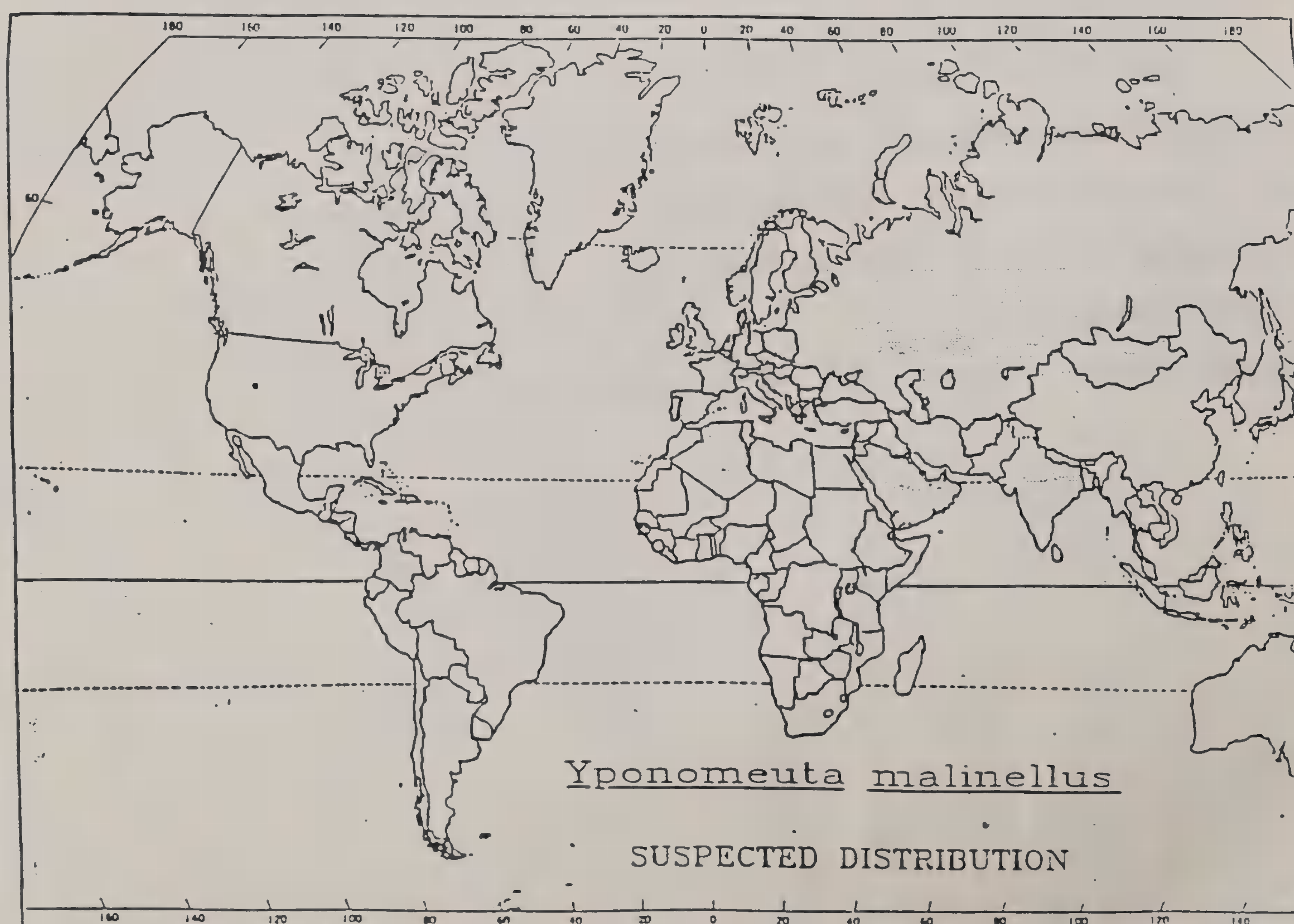
Trap Placement: Within the crown of apple trees.

Recommended Combinations: None

Non-target Species: Unknown. Possibly *Y. cagnagellus*.

Yponomeuta malinellus





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Yponomeuta malinellus

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EXOTIC PEST DETECTION SURVEY RECOMMENDATIONS

Leucoptera malifoliella Pear leaf blister moth
synonymous (*Leucoptera scitella*)

Hosts: Apple,pear, plum and cherry. Found on a wide variety of hosts in the family Rosaceae and on some hosts in the families Betulaceae (Alnus [alder] and Betula [birch]) and Anacardiaceae (Pistacia [pistachio]). See P.N.K.T.O. No. 63

Distribution: See map

Biology: *Leucoptera malifoliella* is a multivoltine Lyonetiid which overwinters as a diapausing pupa in bark crevasses and in the leaf litter around the base of the host. The first adults appear toward the end of March in France, and later in more northern regions. Mating and oviposition begins 50-60 hours after eclosion. Eggs are laid individually on the underside of leaves with each female producing approximately 50 eggs. Eggs begin to hatch ca. 8 days (at 27°C - 28°C) after oviposition . Newly hatching larvae bore through the egg directly into the leaf tissue. The larvae mine the upper epidermal layer,feeding in a widening round spiral mine in the parenchyma. The mine is filled with a trail of dark excrement as the larvae mature. The threshold for larval development has been reported as 8°C (Boureau, 1982) and 12°C (de Pietri-Tonell, et al, 1958). At 15°C, 50 days are required to complete egg and larval development, while at 18°C development can be completed in 35 days and at 20°C, development is completed in 29 days.

Fully grown larvae emerge from the mines through the upper surface of the leaf and begin to search for pupation sites. Larvae of the first generation pupate mainly on leaves, however, later generations pupate in bark crevices or on the fruit. Often the pupae will be found in groups. The pupal stage may last from 12-13 days (23°C) to 28 days (15°C). One to five generations of the insect may develop per year depending on the length of growing season.

It appears that this species become an important pest in well managed orchards. In orchards where management includes use of pesticides, natural enemies are decreased to the point that *L. malifoliella* builds to damaging levels.

Pathways: A pathway which potentially could lead to introduction of this species is through commercial shipments of apples from Europe. Inspections of fruit are difficult because of the small pupal size (3mm) and its cryptic location, usually within the calyx. Non-commercial movement of fruit poses an unknown degree of risk of entry. Other potential pathways include importation of nursery stock or scion material. Material from all known pathways are subject to inspection.

Potential U.S. distribution: Throughout the U.S., wherever host plants occur. (See map)

Recommended survey areas: Major apple and pear producing areas (see map). Because of the wide host range of this species, surveys may be conducted in hosts other than apple or pear. Pathways studies may reveal other potential sources of introduction, however, the survey's effort should be concentrated in areas where there is a known pathway including nurseries importing stock, and urban areas where non commercial shipments of fruit may be received, and generally throughout commercial areas.

Pheromone: 5,9-dimethylheptadecane dispenser type, rubber septa field life - 2 weeks.

Source of pheromone dispensers: Otis Methods Development Laboratory

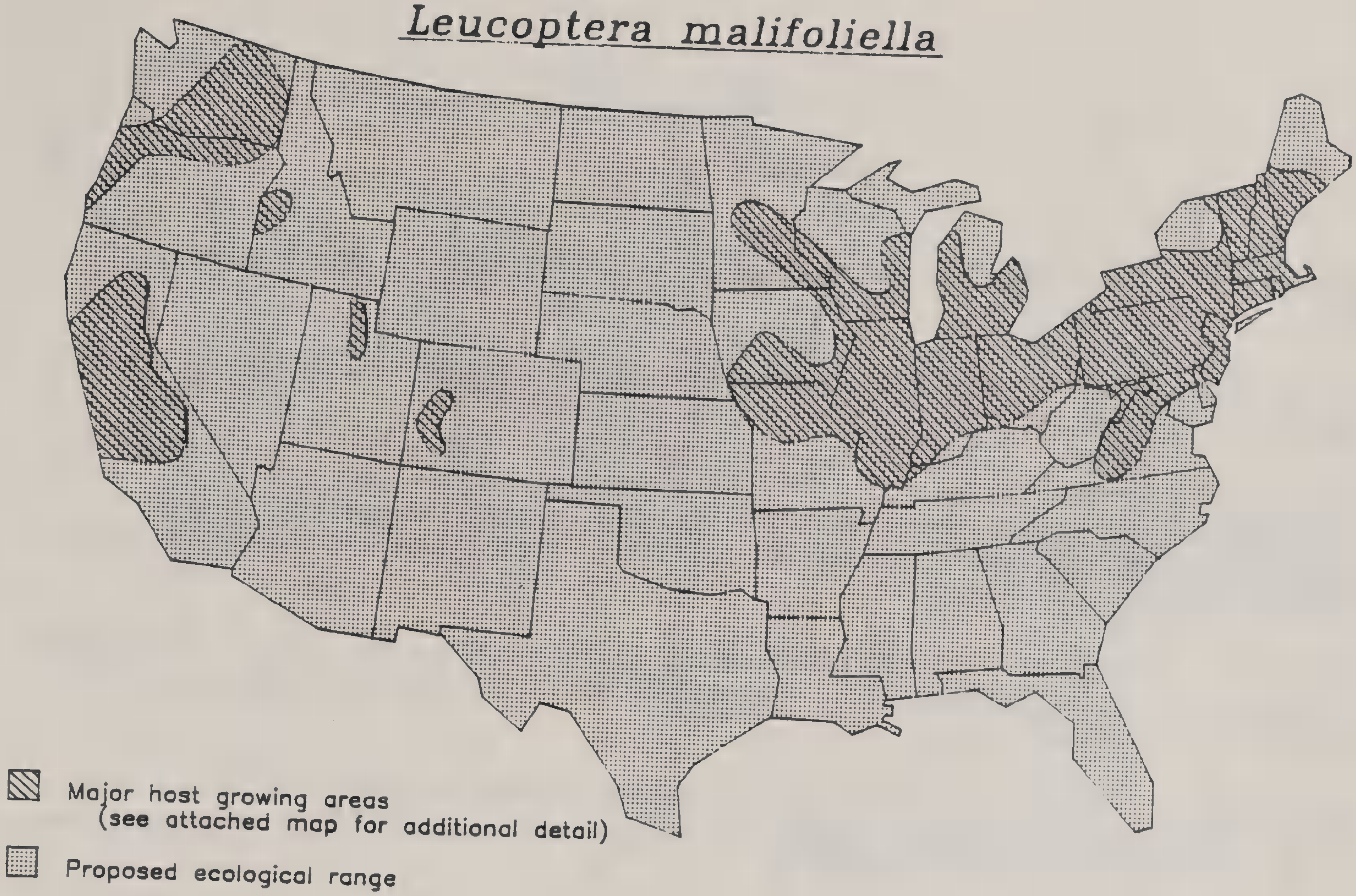
Traps: United Agri Products and Trece Wing Traps

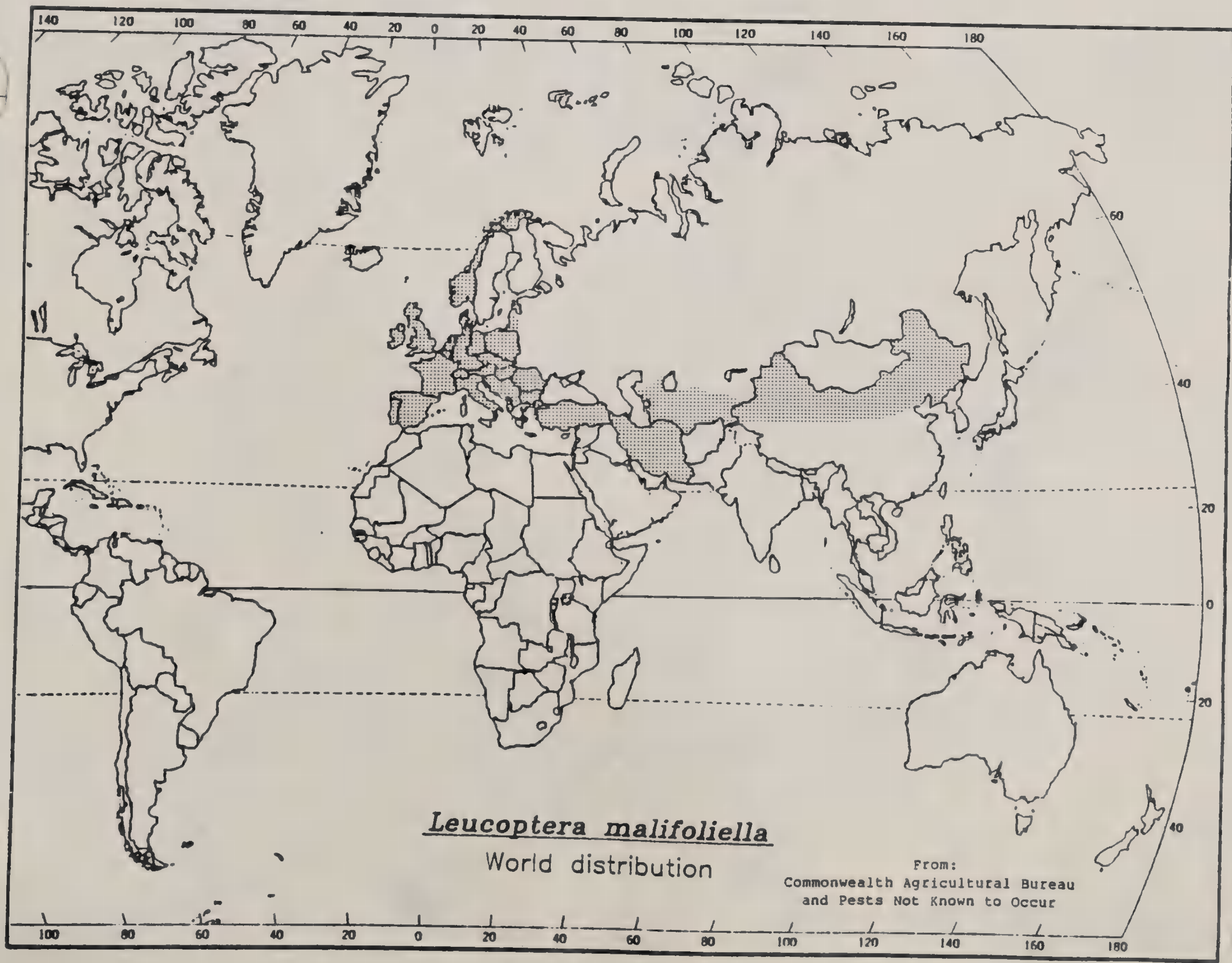
Trap placement: On host trees at approximately 1 to 1.5m in height

Recommended Combinations: None presently recommended

Non-target species that may be captured: None presently known. Six species of the genus *Leucoptera* are known to occur in the United States and they potentially could be attracted to the pheromone for *L. scitela*.

Leucoptera malifoliella





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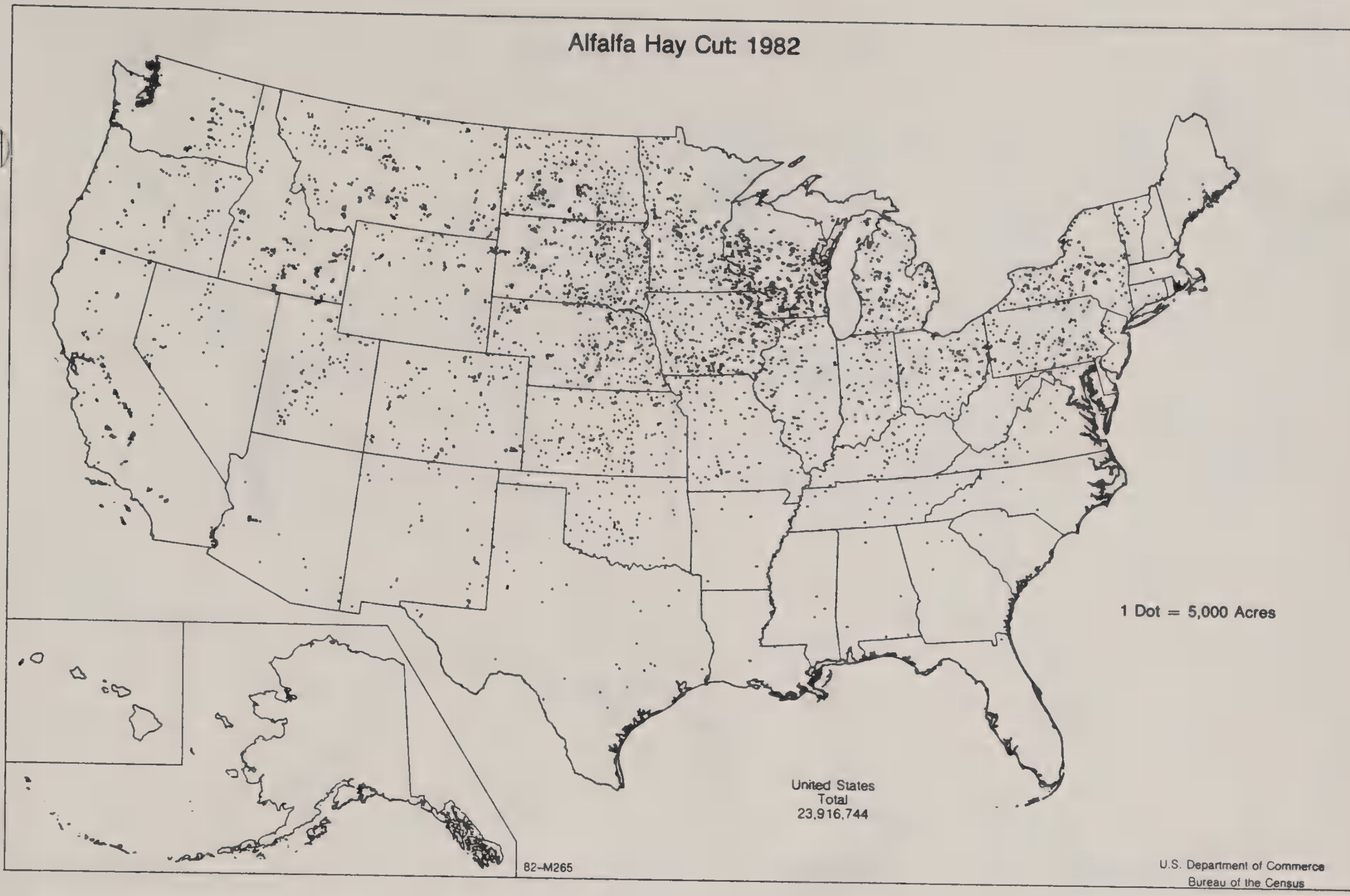
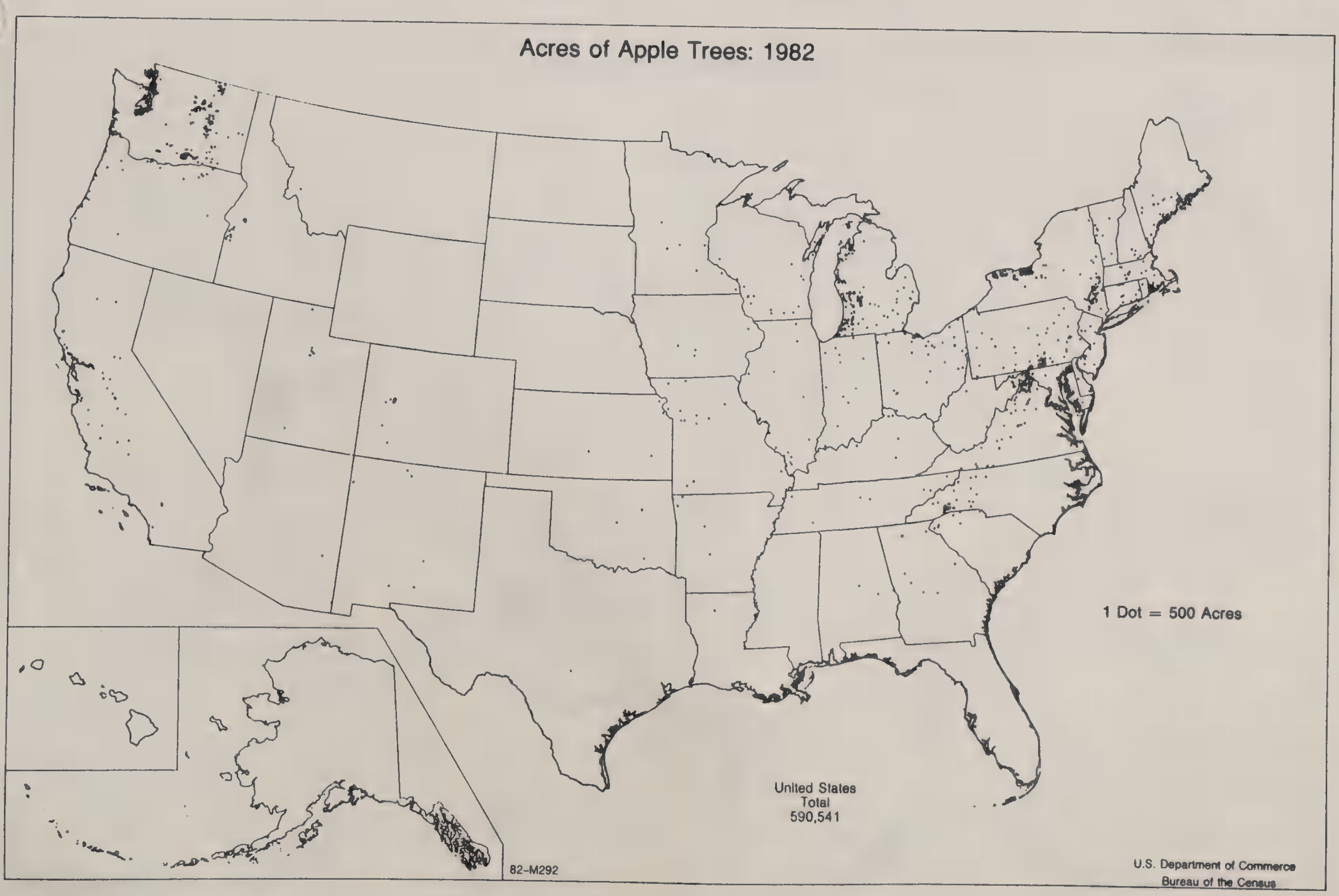
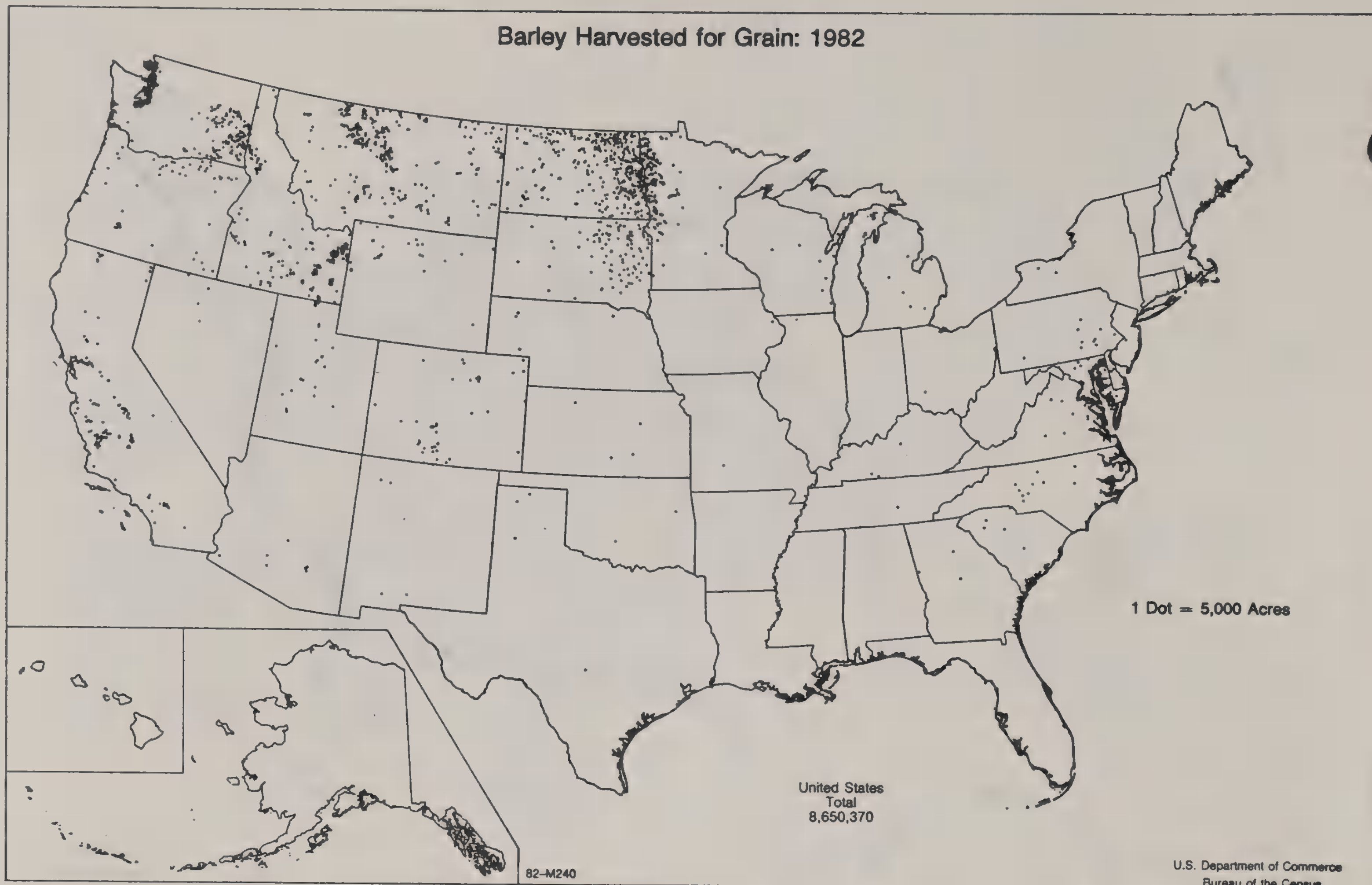
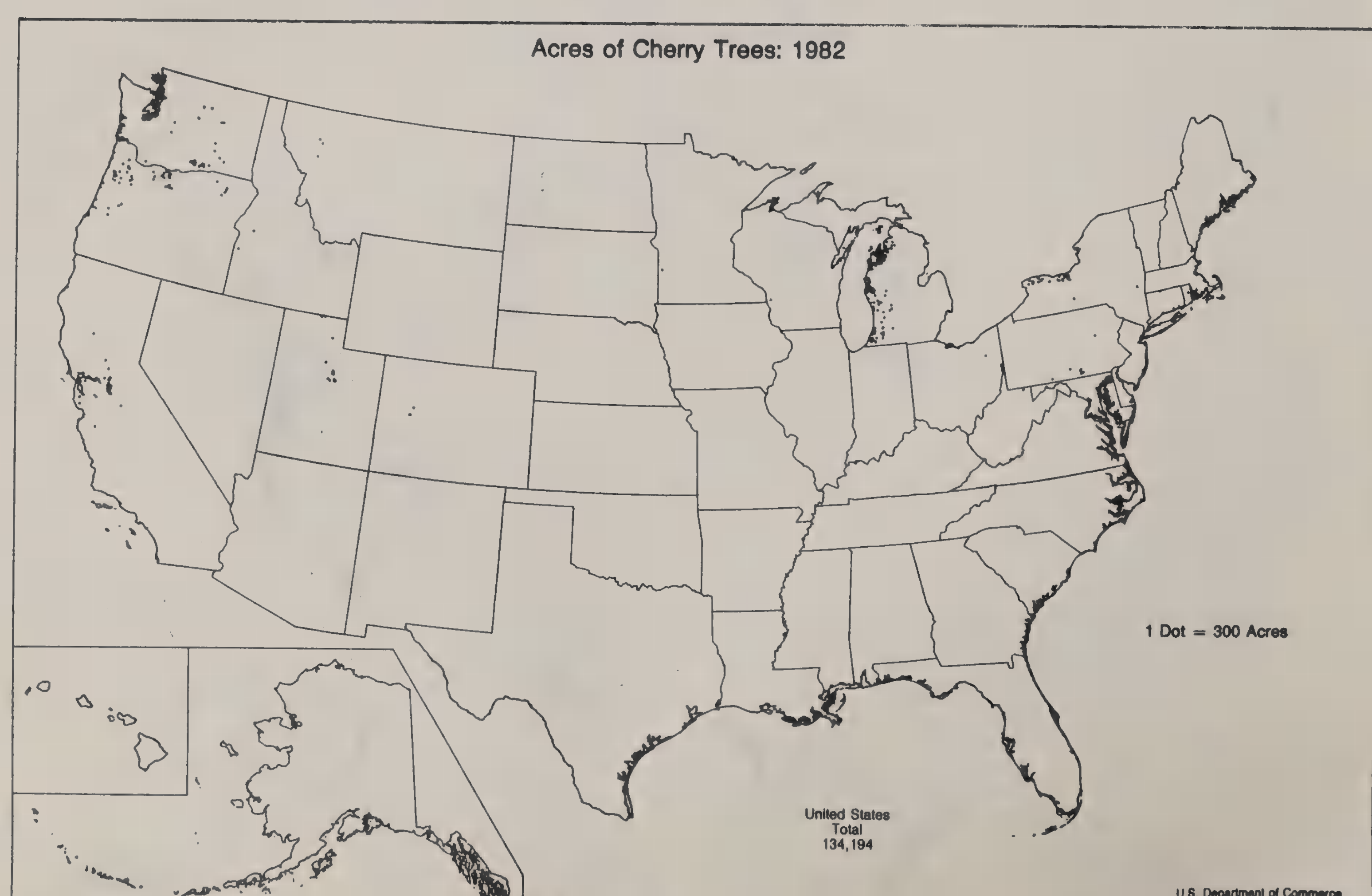
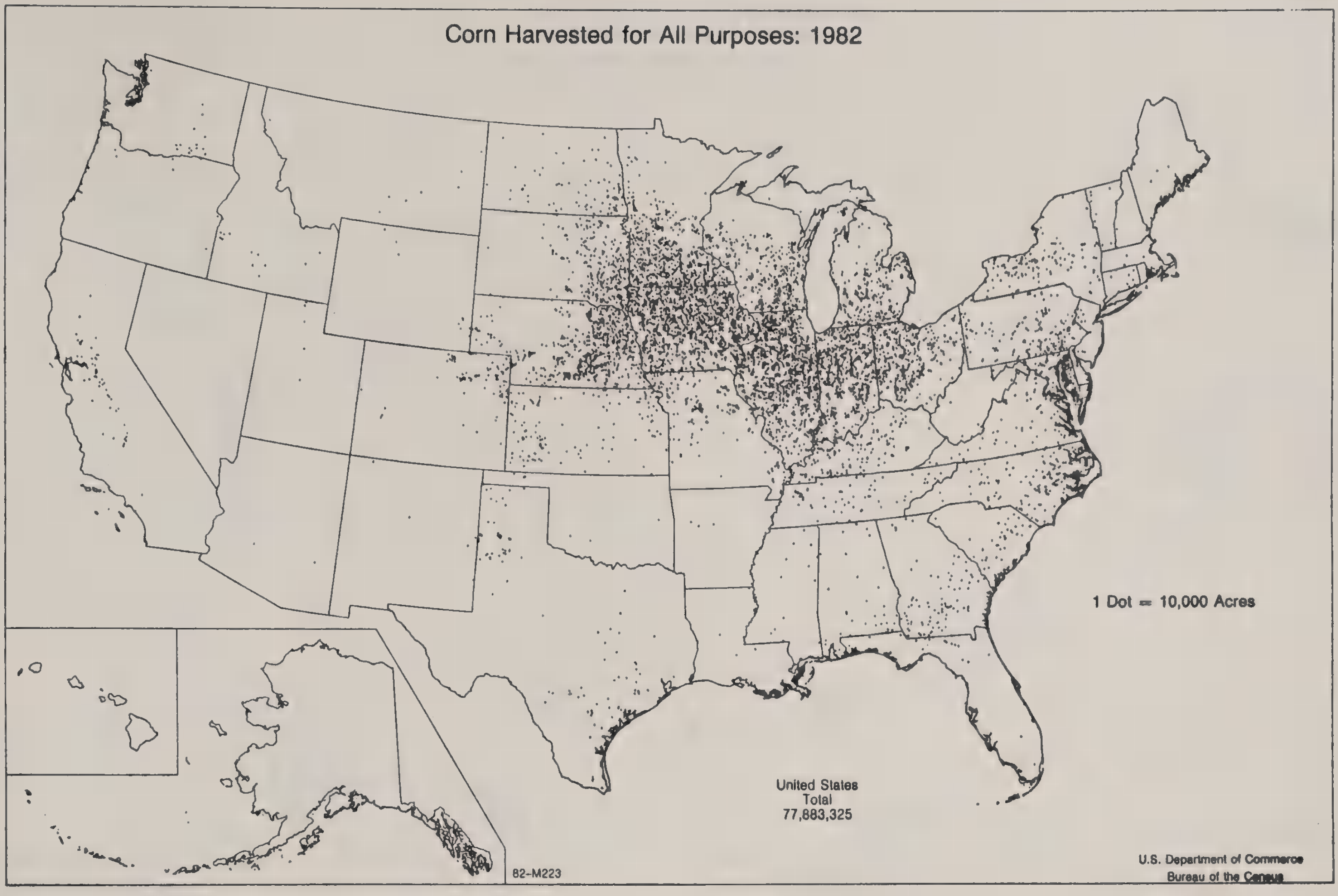
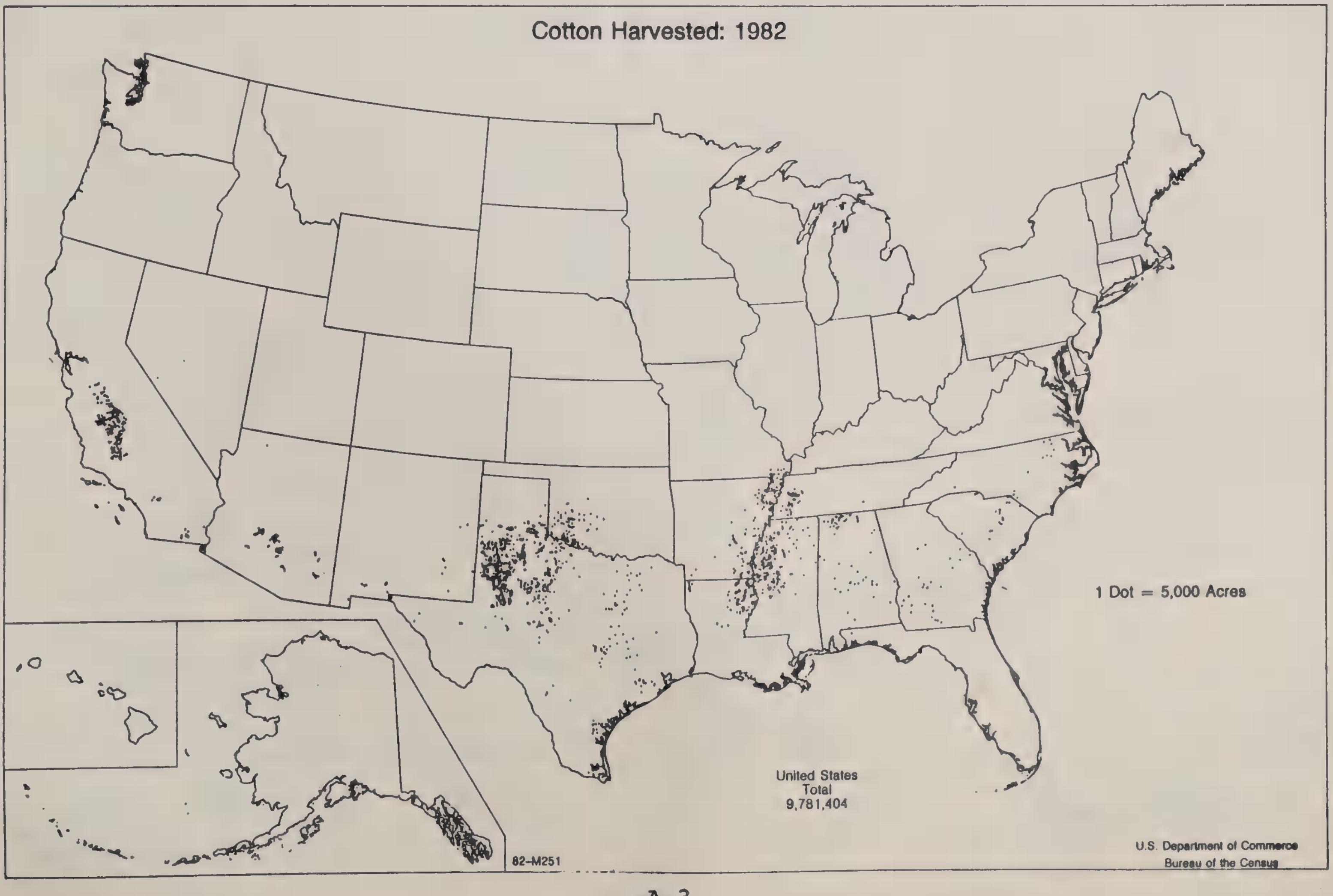

Alfalfa Hay Cut: 1982
1 Dot = 5,000 Acres
United States
Total
23,916,744
82-M265
U.S. Department of Commerce
Bureau of the Census

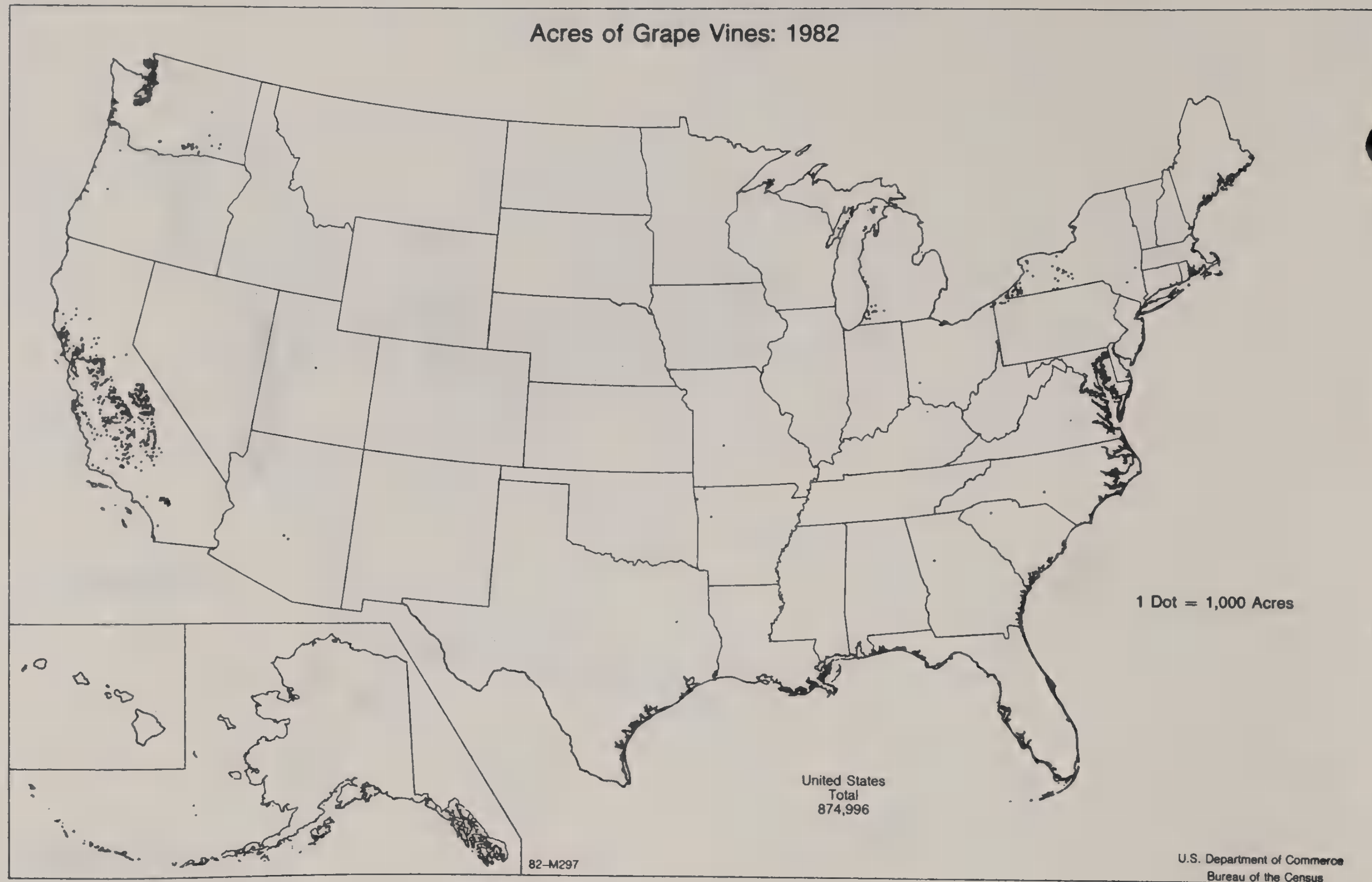

Acres of Apple Trees: 1982
1 Dot = 500 Acres
United States
Total
590,541
82-M292
U.S. Department of Commerce
Bureau of the Census

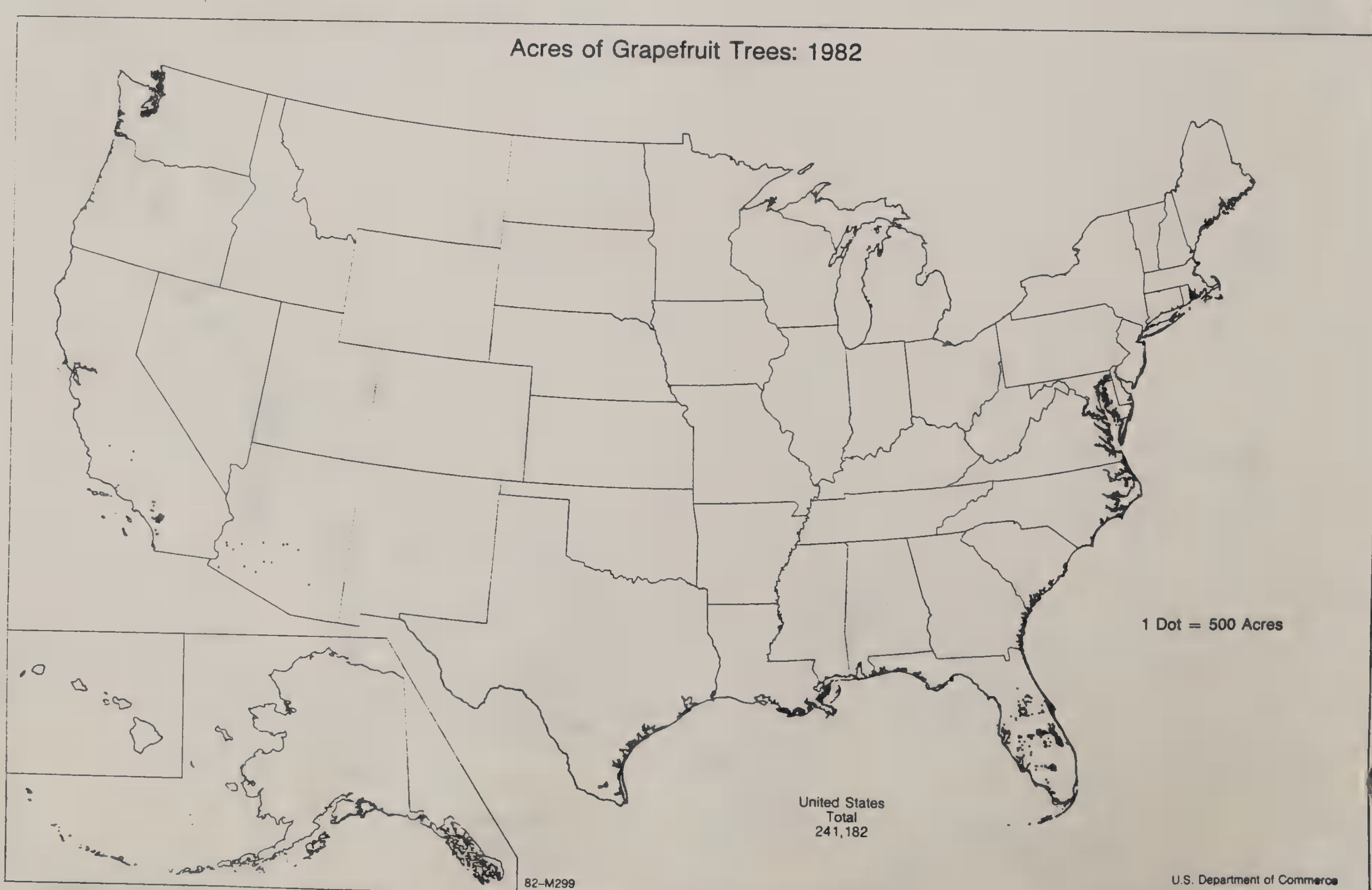

Barley Harvested for Grain: 1982
1 Dot = 5,000 Acres
United States
Total
8,650,370
82-M240
U.S. Department of Commerce
Bureau of the Census

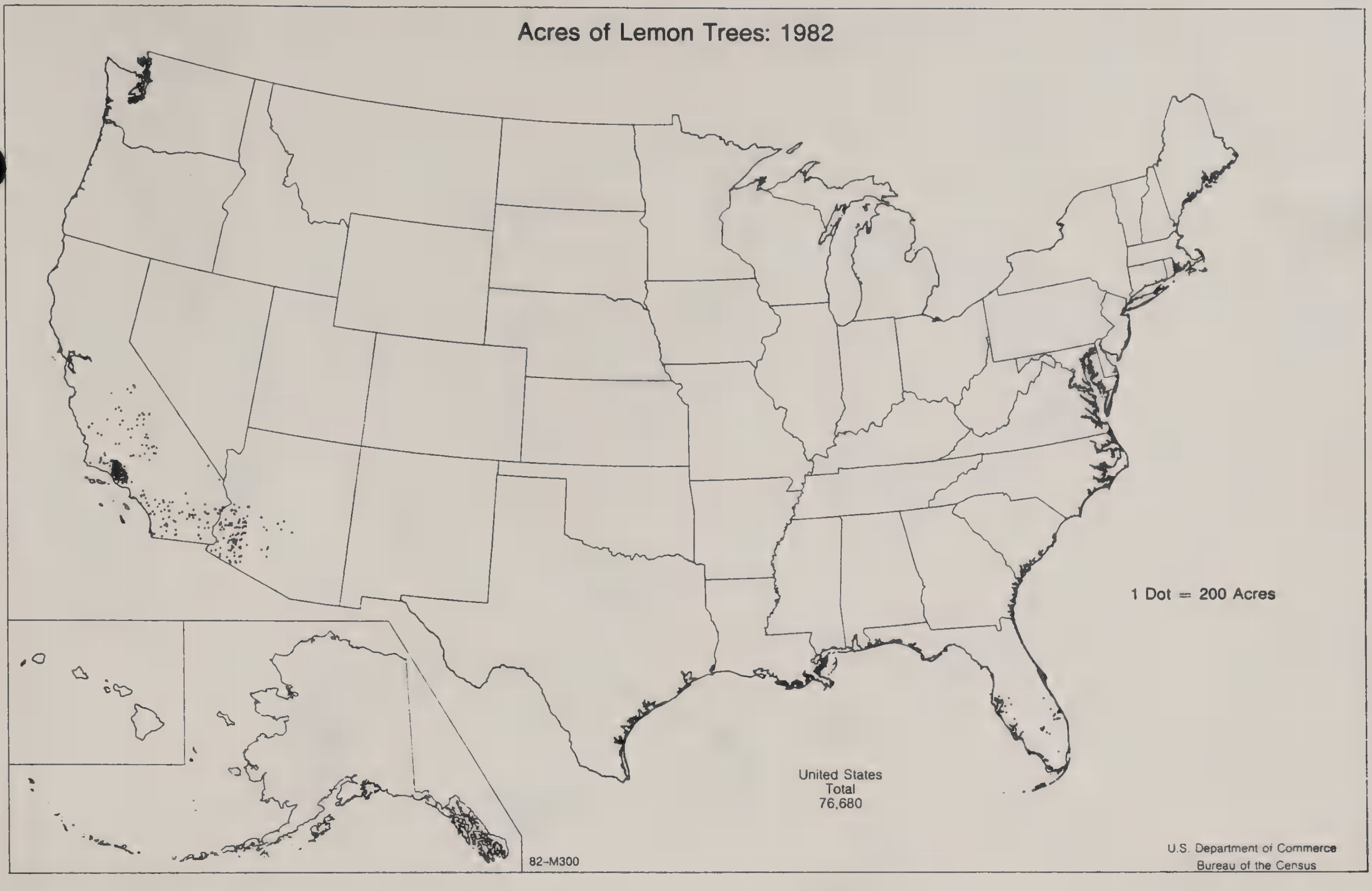

Acres of Cherry Trees: 1982
1 Dot = 300 Acres
United States
Total
134,194
82-M295
U.S. Department of Commerce
Bureau of the Census

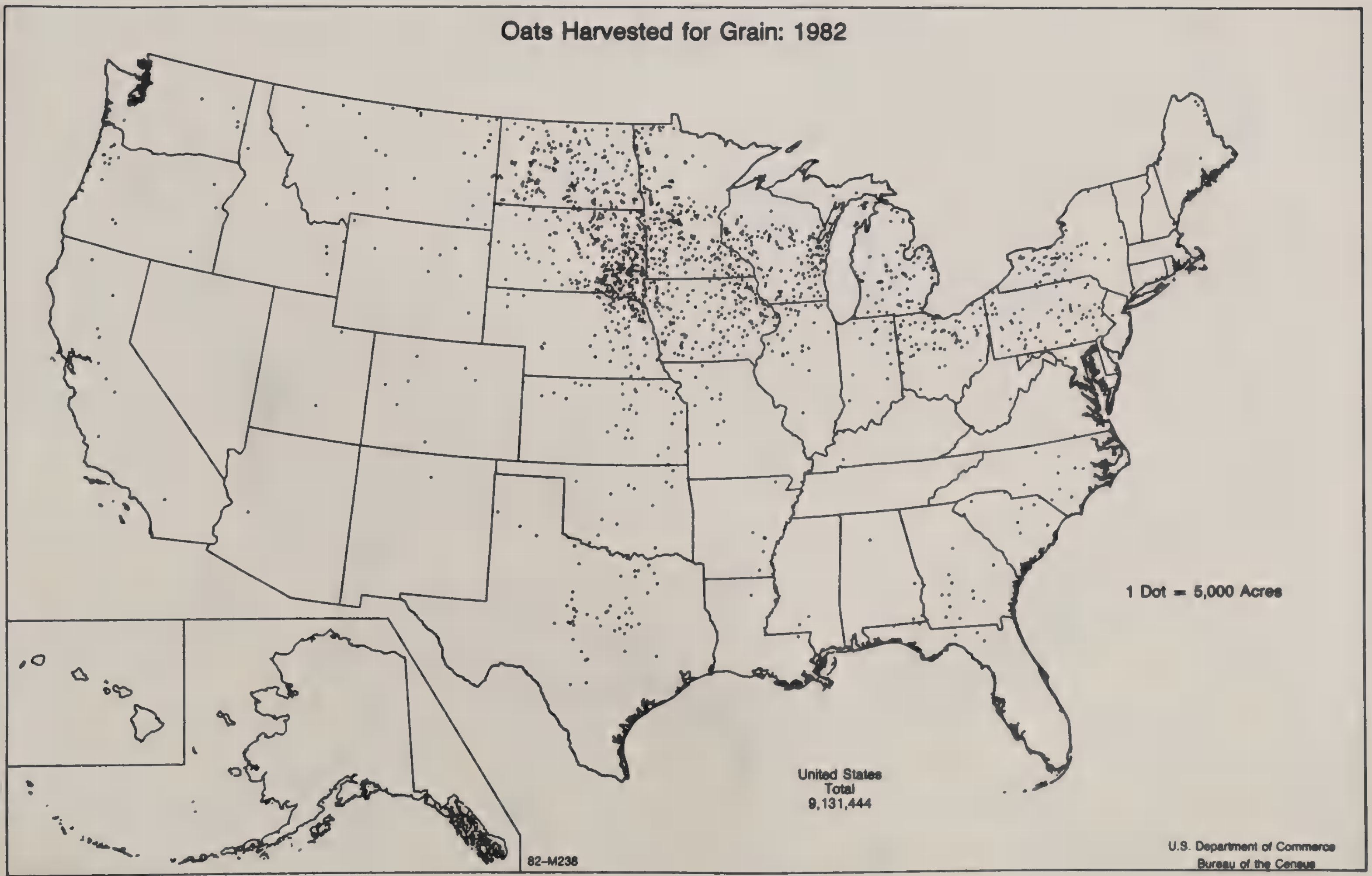

Corn Harvested for All Purposes: 1982
1 Dot = 10,000 Acres
United States
Total
77,883,325
82-M223
U.S. Department of Commerce
Bureau of the Census

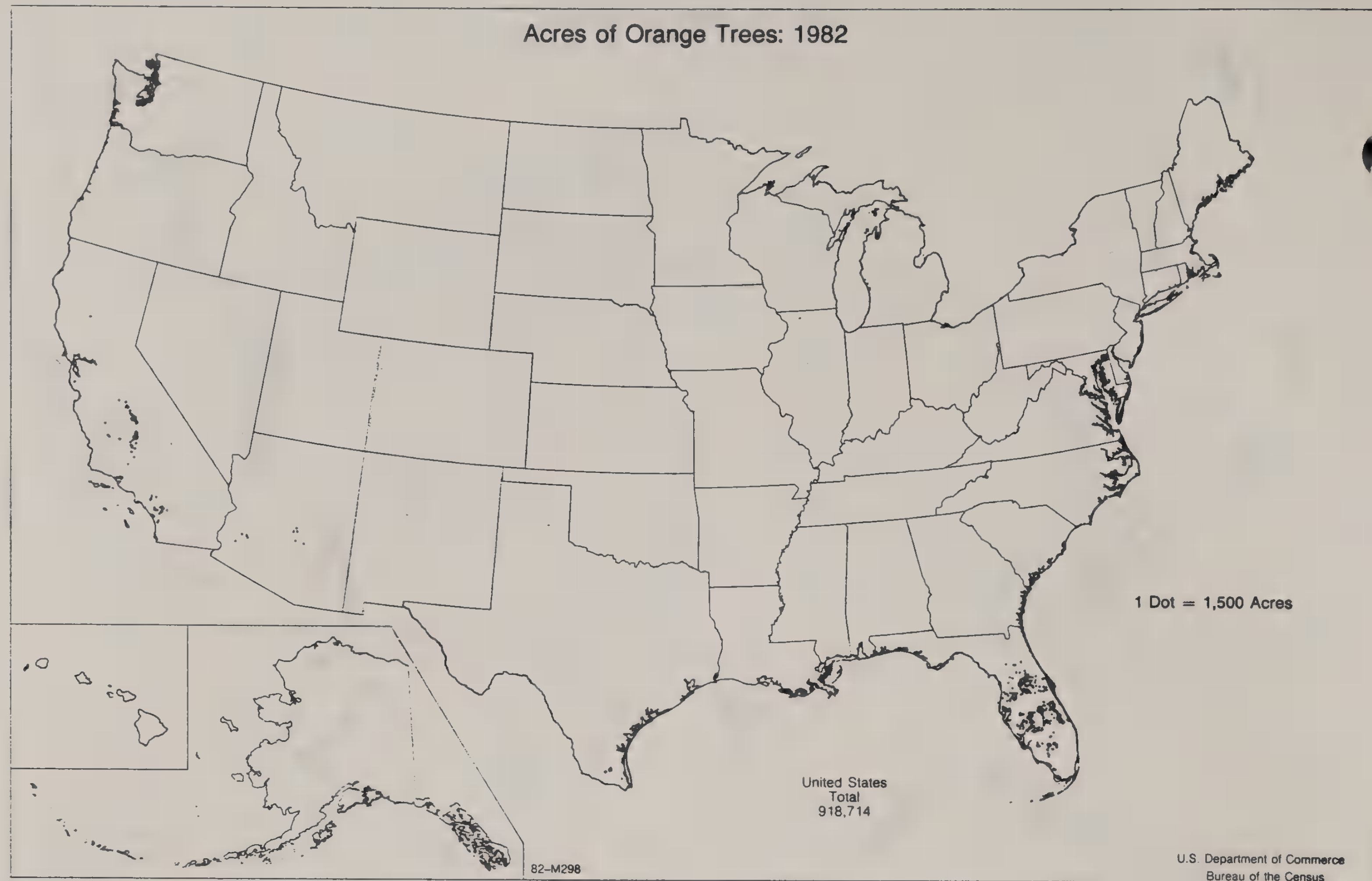

Cotton Harvested: 1982
1 Dot = 5,000 Acres
United States
Total
9,781,404
82-M251
U.S. Department of Commerce
Bureau of the Census

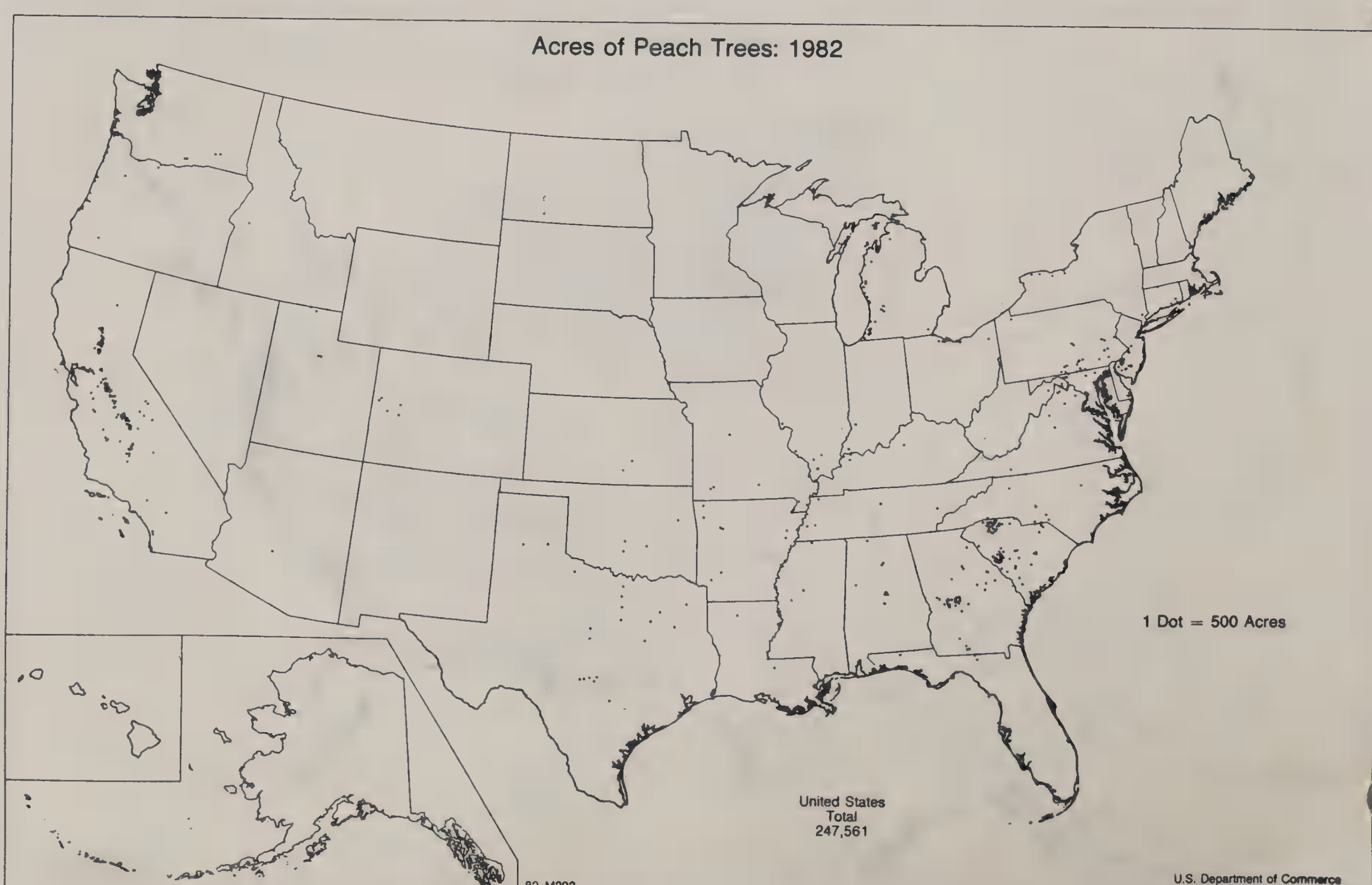

Acres of Grape Vines: 1982
1 Dot = 1,000 Acres
United States
Total
874,996
82-M297
U.S. Department of Commerce
Bureau of the Census

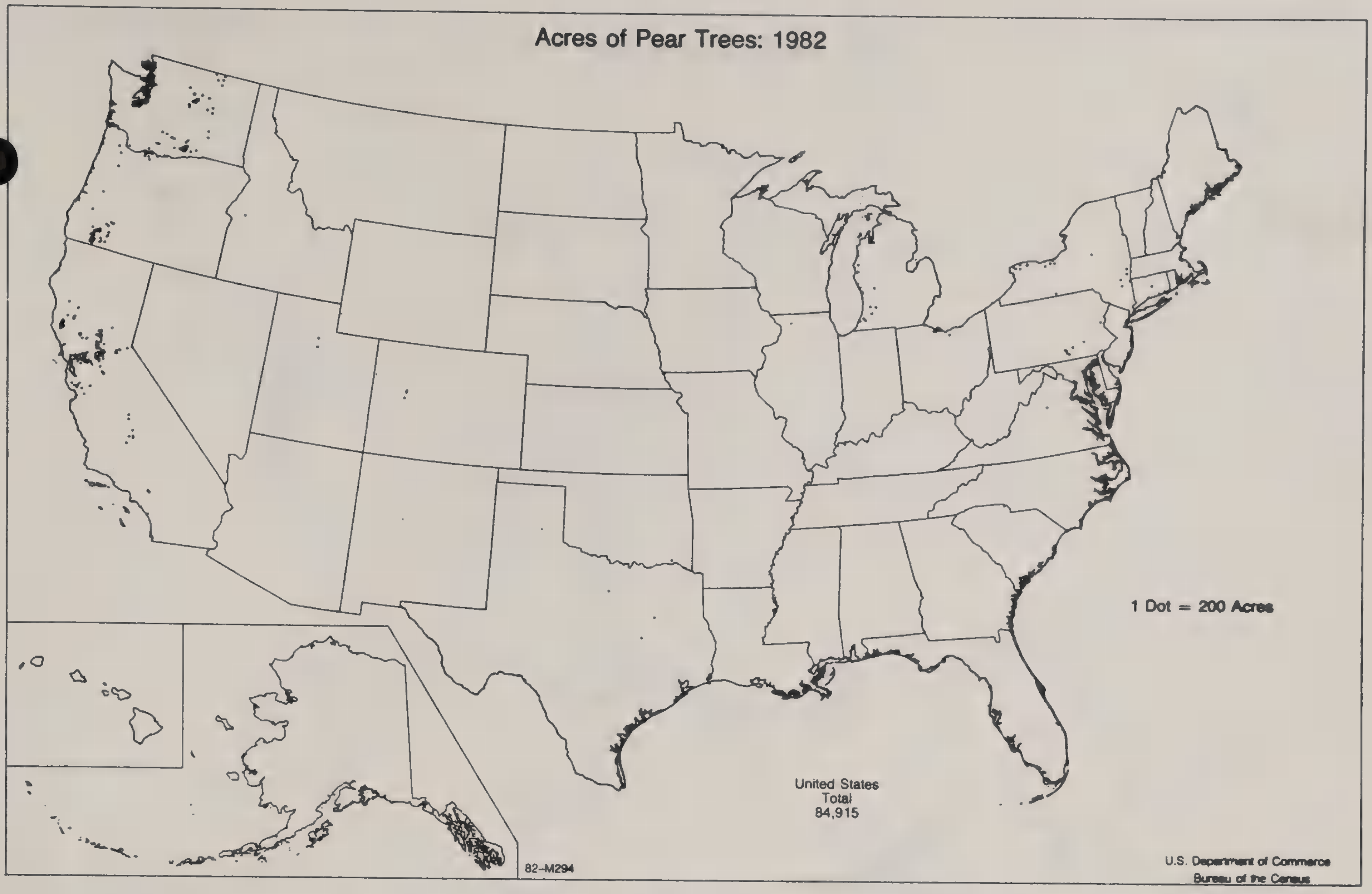

Acres of Grapefruit Trees: 1982
1 Dot = 500 Acres
United States
Total
241,182
82-M299
U.S. Department of Commerce
Bureau of the Census

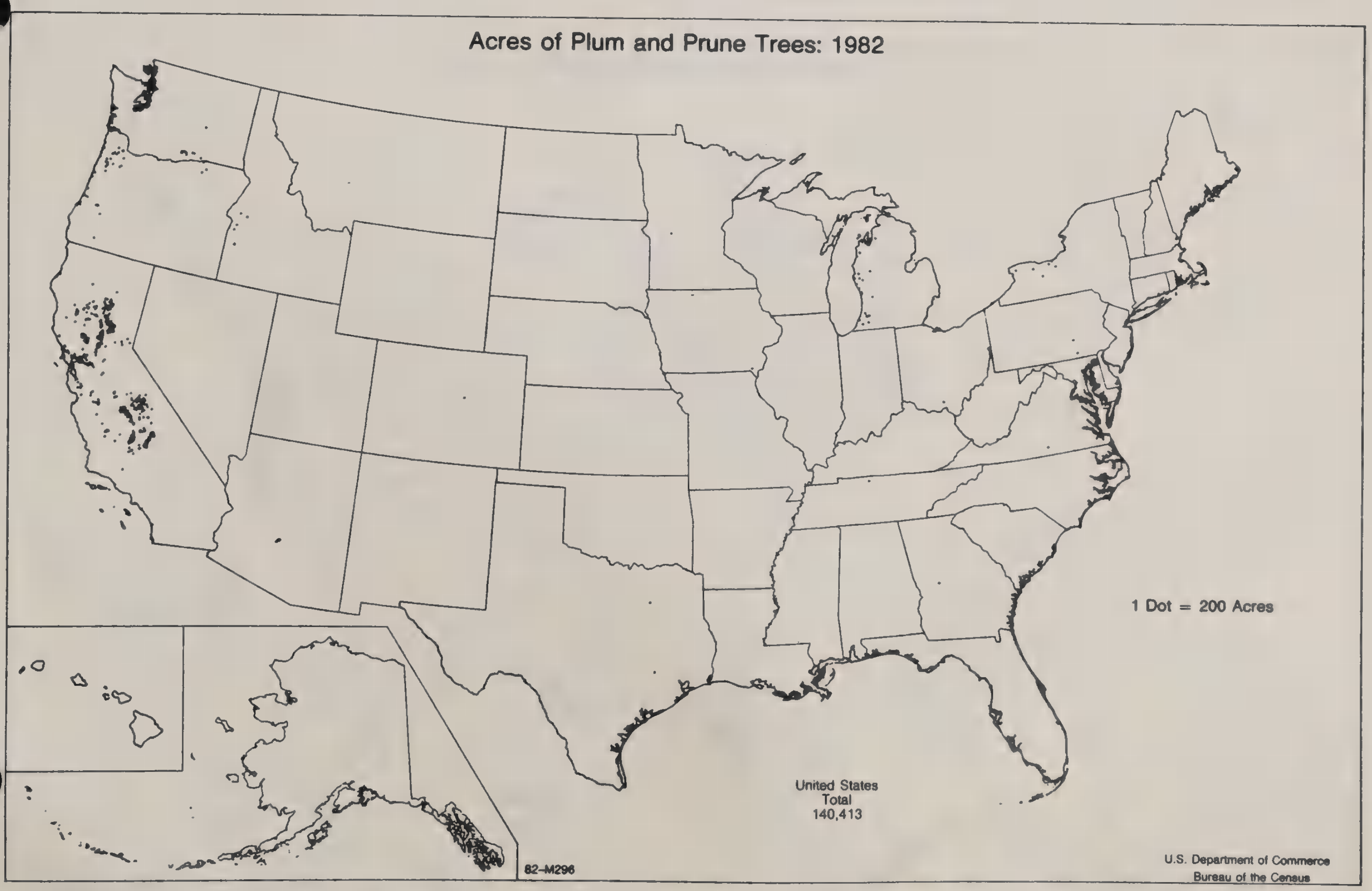

Acres of Lemon Trees: 1982
1 Dot = 200 Acres
United States
Total
76,680
82-M300
U.S. Department of Commerce
Bureau of the Census

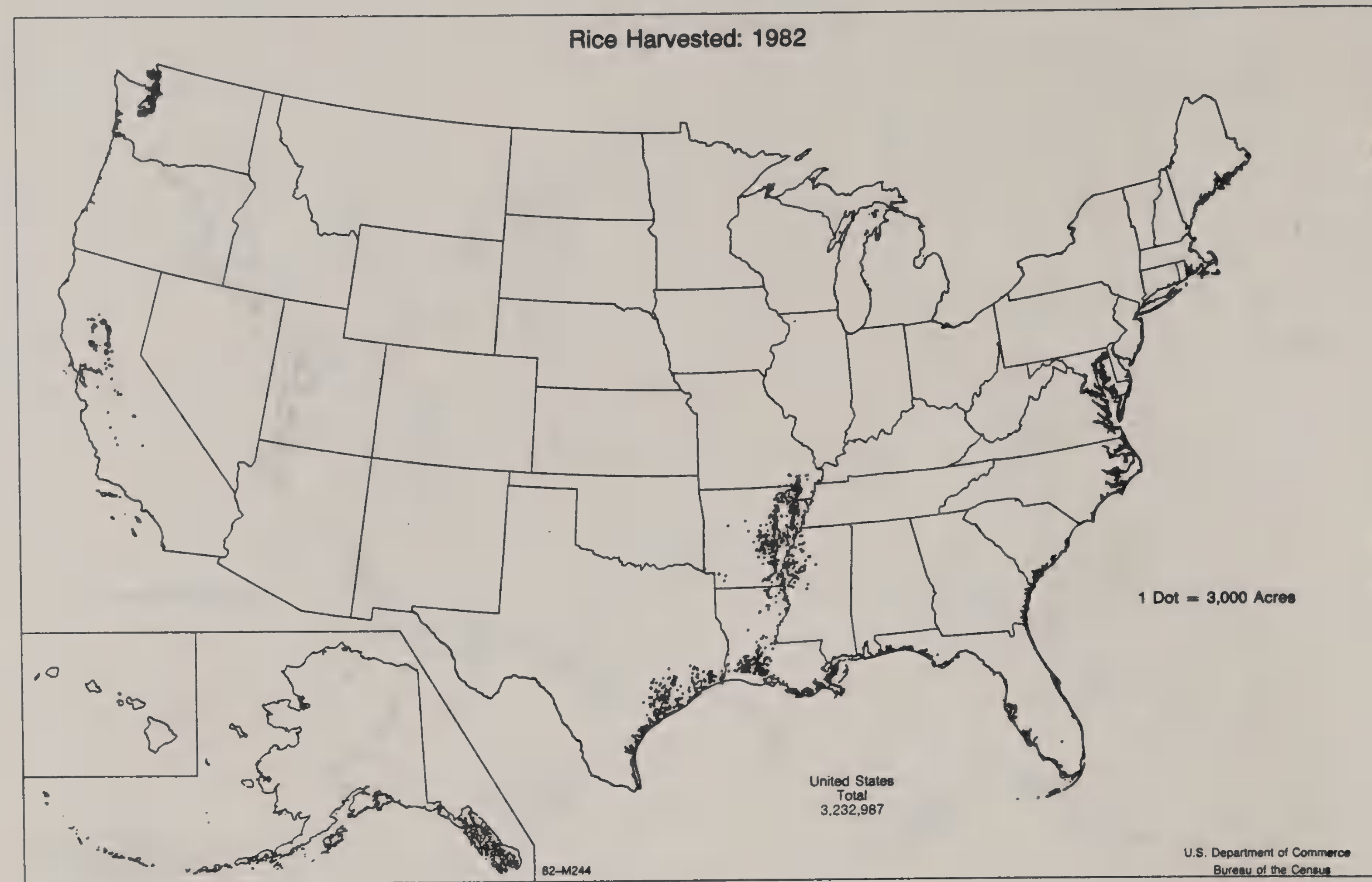

Oats Harvested for Grain: 1982
1 Dot = 5,000 Acres
United States
Total
9,131,444
82-M238
U.S. Department of Commerce
Bureau of the Census

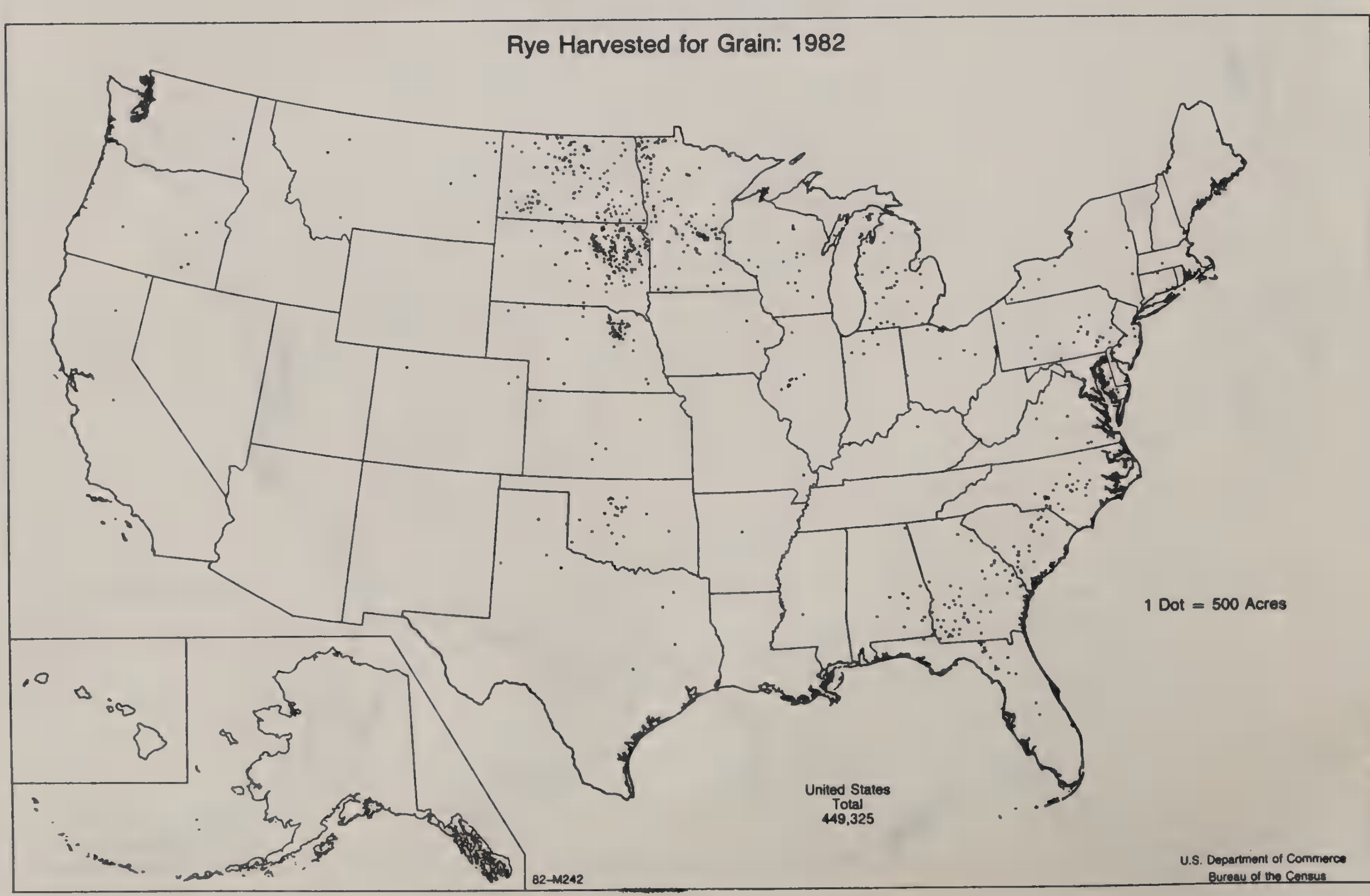

Acres of Orange Trees: 1982
1 Dot = 1,500 Acres
United States
Total
918,714
82-M298
U.S. Department of Commerce
Bureau of the Census

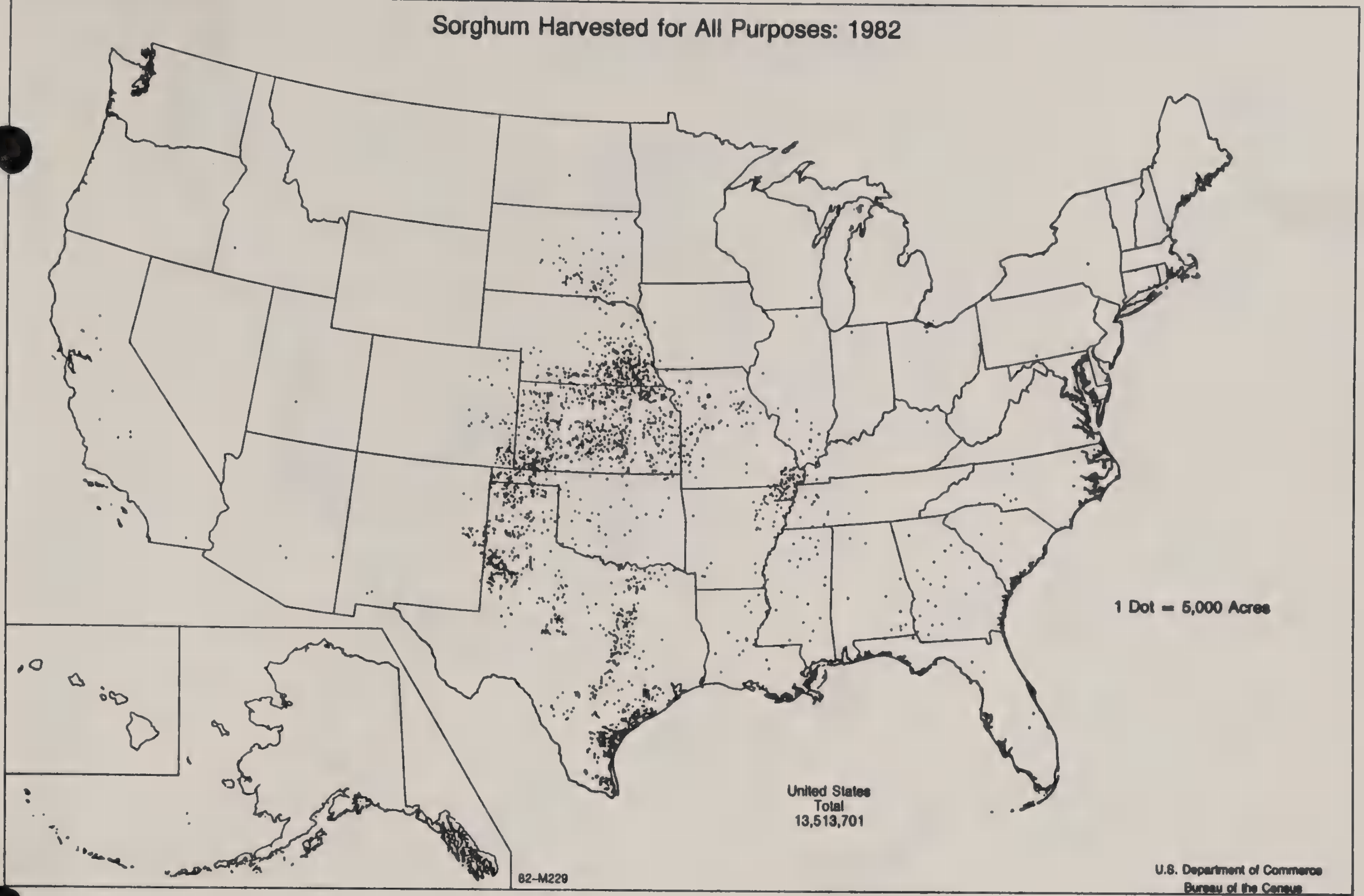

Acres of Peach Trees: 1982
1 Dot = 500 Acres
United States
Total
247,561
82-M293
U.S. Department of Commerce
Bureau of the Census

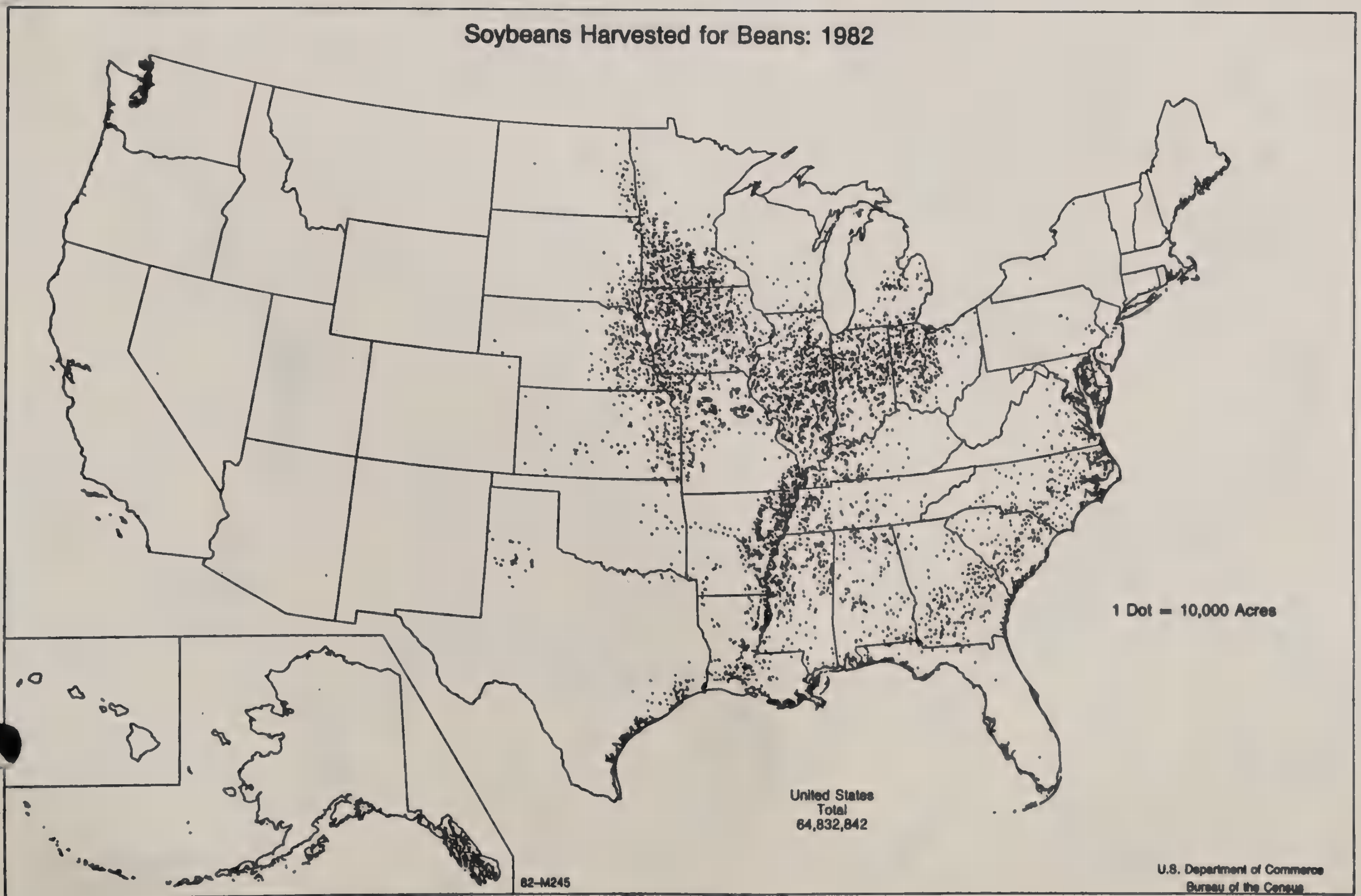

Acres of Pear Trees: 1982
1 Dot = 200 Acres
United States
Total
84,915
82-M294
U.S. Department of Commerce
Bureau of the Census


Acres of Plum and Prune Trees: 1982
1 Dot = 200 Acres
United States
Total
140,413
82-M296
U.S. Department of Commerce
Bureau of the Census

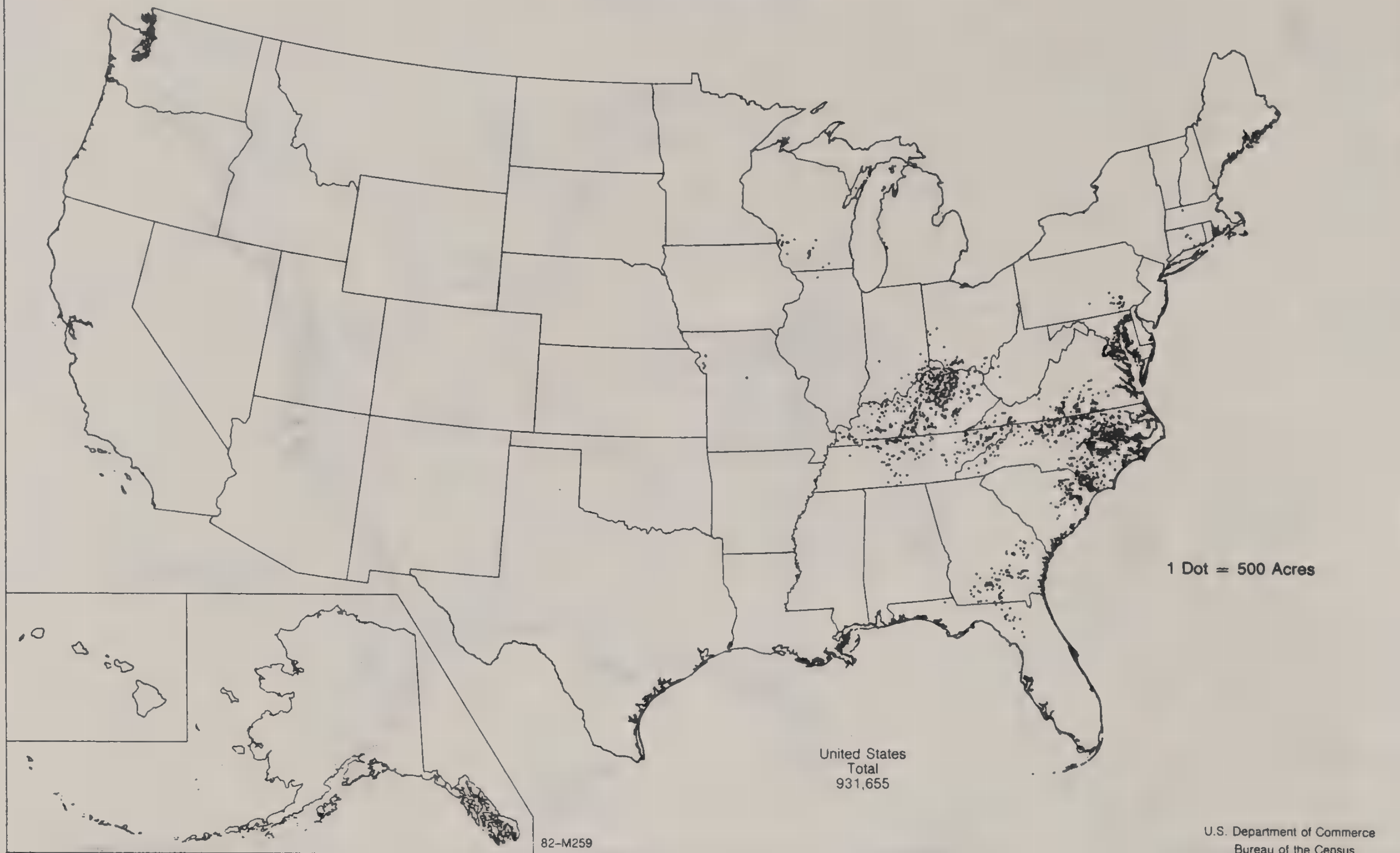

Rice Harvested: 1982
1 Dot = 3,000 Acres
United States
Total
3,232,987
82-M244
U.S. Department of Commerce
Bureau of the Census


Rye Harvested for Grain: 1982
1 Dot = 500 Acres
United States
Total
449,325
82-M242
U.S. Department of Commerce
Bureau of the Census

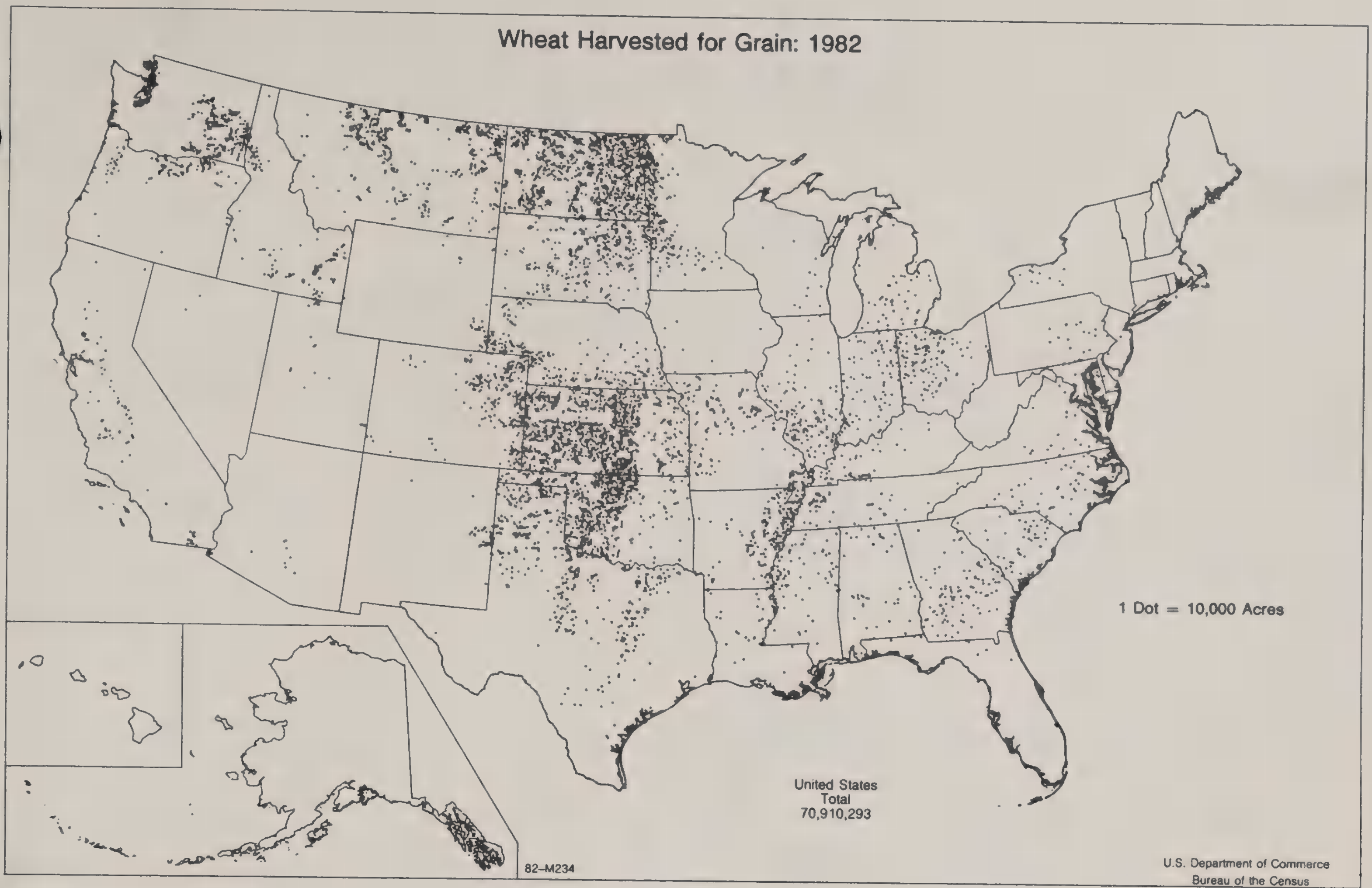

Sorghum Harvested for All Purposes: 1982
1 Dot = 5,000 Acres
United States
Total
13,513,701
82-M229
U.S. Department of Commerce
Bureau of the Census


Soybeans Harvested for Beans: 1982
1 Dot = 10,000 Acres
United States
Total
64,832,842
82-M245
U.S. Department of Commerce
Bureau of the Census

Tobacco Harvested: 1982



Vegetables Harvested for Sale: 1982


Wheat Harvested for Grain: 1982
1 Dot = 10,000 Acres
United States
Total
70,910,293
82–M234
U.S. Department of Commerce
Bureau of the Census

Appendix B

A List of Target Insect and Non-Target Insect
That May Be Captured

Target Species	Non-Target Family/Genus/Species
Adoxophyes orana Summer fruit tortrix	Noctuidae: *Leucania* spp. Nymphalidae: *Asterocampa celtis* Tortricidae: *Argyrotaenia velutinana*, *Choristoneura rosaceana*, *Grapholita molesta*, *Pandemis limitata*, *Pandemis pyrusana*
Autographa gamma Silver Y-moth	Noctuidae: *Anagrapha falcifera*, *Autographa ampla*, *Autographa biloba*, *Autographa californica*, *Caenurgina* spp., *Lacanobia lutra*, *Lacinipolia renigera*, *Ochropleura plecta*, *Polias* spp., *Pseudoplusia includens*, *Rachiplusia ou*, *Spodoptera ornithogalli*, *Syngrapha falcifera* Pieridae: *Pieris rapae* Pterophoridae: *Geina periscelidactyla* Pyralidae: *Ostrinia nubilalis*, *Helvibotys helvialis* Tortricidae: *Episemus argutanus*
Chilo partellus Maize borer	Noctuidae: *Heliothis zea* Ctenuchidae: *Cisseps fulvicollis*
Chilo suppressalis Asiatic rice borer	No Non-Target insects reported.
Cryptophlebia leucotreta False codling moth	Noctuidae: *Hyperstrotia* spp. Tortricidae: *Cydia cupressana*, *Cryptophlebia peltastica* (exotic)

Target Species	Non-Target Family/Genus/Species
Cydia funebrana Plum fruit moth	Gracillariidae: *Phyllonorycter blancardella* Tortricidae: *Grapholita prunivora*, *Grapholita molesta**

*This non-target species', the oriental fruit moth, external appearance is very similar to the plum fruit moth. Because of the similarity, separation of the two species is difficult. Serious consideration should be given to identification problems when a trapping program is planned for the plum fruit moth.

Target Species	Non-Target Family/Genus/Species
Epiphyas postvittana Light brown apple moth	Gracillariidae: *Phyllonorycter* spp. Pyralidae: *Pyrausta rubricalis* Tortricidae: *Archips rosaceana*
Eupoecilia ambiguella European grape berry moth	Gelechiidae: *Phthorimaea operculella* Geometridae: *Eusarca confusara* Noctuidae: *Autographa precationis*, *Faronta diffusa* Oecophoridae: *Agonopterix pulvitennella* Tortricidae: *Argyrotaenia velutiana*, *Endopiza viteana*, *Episemus argutanus*, *Grapholita prunivora*, *Phaneta crispana*, *Pseudogalleria inimicella*, *Ptycholoma teritana*
Leucoptera malifoliella Pear leaf blister moth	No non-target insects reported.
Lobesia botrana Grape vine moth	No non-target insects reported.
Mamestra brassicae Cabbage moth	Pieridae: *Pieris rapae* Noctuidae: *Abrostola urentis*, *Aletia oxygala*, *Autographa californica*, *Faronta diffusa*, *Laconobia lutra*, *Orthodes crenulata*, *Ploia detracta*, *Polias* spp., *Pseudaletia unipuncta*, *Scotogramma trifolii*

Cryptophlebia leucotreta (Meyr.)

Lobesia botrana (D.&S.)

Mamestra brassicae L.

Epiphyas postvittana (Walk.),male

Epiphyas postvittana (Walk.),male

Epiphyas postvittana (Walk.),male

Epiphyas postvittana (Walk.),male

Cydia funebrana (Treit.)

Autographa gamma L.

Adoxophyes orana (F.v.R.),male

Adoxophyes orana (F.v.R.),female

Eupoecilia ambiguella Hubner

Chilo partellus (Swin.)

Chilo suppressalis (Walk.)

Spodoptera litura (Fab.),male

Spodoptera litura (Fab.),female

Spodoptera littoralis (Bois.)

Cooperative National Plant
Pest Survey and Detection
Program